Creating Age Models and Chronologies

Tilia can create age models and chronologies. You can also enter chronological data generated from other age-model software.

A **Chronology** is a series of ages assigned to sample depths. An **Age Model** has two components: (1) a series of age-depth points and (2) an algorithm for assigning ages to individual sample depths.

In the spreadsheet, ages are assigned to samples in a row having the Code **#ChronX**, where X is a number, e.g. **#Chron1**. Multiple chronologies may be assigned with different numbers. The chronology name can by anything. In the example below, sample 1700 has an age of 6611 cal yr BP.

Data | Metadata

	A	B	C	D	G	H	I	J	K	L	M
1	pollen					1700	1712	1713	1721	1725	1726
2	Code	Name	Element	Units	Group						
3	#Chron1	Gonzales & Grimm 2009		cal yr BP		6611	6955	6984	7214	7328	7357
4	#Chron2	Neotoma 1		cal yr BP		6614	6936	6963	7182	7294	7321
5	#Chron2.Old	Neotoma 1 Older Bound		cal yr BP		6773	7217	7249	7427	7508	7518
6	#Chron2.Young	Neotoma 1 Younger Bound		cal yr BP		6467	6682	6697	6900	7026	7066

Tilia uses these ages to plot the data against age with either a primary or secondary age scale. The sample ages may be generated by Tilia or may be from other age-model software and typed or pasted into the spreadsheet.

Chronologies

To generate a chronology in Tilia, the age-model data must be entered in the **Age Models** tabsheet under **Metadata**. In the example below two age models are assigned.

Data | Metadata

Site | Collection Unit | Dataset | Geochronology | Age Models | Lithology | LOI | Contacts | Publications

Auto Chron Numbers

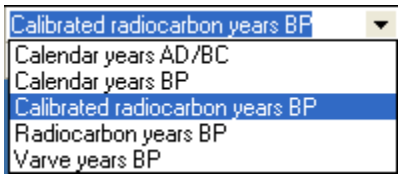
	Chron No.	Name	Age Units	Default	Age Model	Older Bound	Younger Bound	Preparers	Date Prepared	Notes
*	Click here to add a new row									
⊞	1	Gonzales & Grimm...	Calibrated rad...	☐	linear interpolation	6610	16520	Gonzales, L.M.	1/1/2009	Dates calibrated ...
⊞	2	Grimm1	Calibrated rad...	☑	linear interpolation	6590	16930	Grimm, E.C.	5/10/2010	Dates calibrated ...

The fields are:

Chron No Chronology number. This number will be assigned automatically if the **Auto Chron Numbers** button is pushed down. Otherwise the user must assign a unique number to each chronology.

Name Name of the chronology. In this example, the name «Gonzales and Grimm 2009» refers to the published age mode, which used the IntCal04 calibration curve. The second chronology was created by Grimm using the IntCal09 calibration curve.

Age Units The age units of the Chronology. In this case «Calibrated radiocarbon years BP». The age units are selected from a pick list.



Default The default age model is checked. There may be a default age model for different age units. For example, different default age models may exist for Calibrated radiocarbon years BP and Radiocarbon years BP. However, there may be only one default age model for each type of age units. Please note: for calibrated radiocarbon ages, «cal yr BP» refers to «calibrated», not «calendar». The datum for all BP ages is AD 1950.

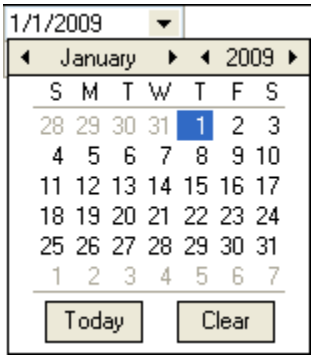
Age Model The algorithm used to assign ages to individual sample depths. In this case, linear interpolation.

Older Bound The older reliable age bound of the chronology. The **Age Bounds** are the bounds within which the chronology is considered reliable. Ages may be assigned outside the Age Bounds for the purpose of plotting a diagram against age, but the ages are nevertheless considered unreliable; for example, sample ages extrapolated below the lowermost radiocarbon age. The Age Bounds are not necessary for Tilia, but are used in databases.

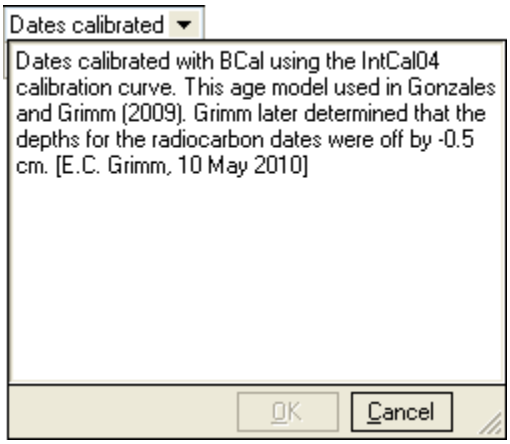
Younger Bound The younger reliable age bound of the chronology.

Preparers The person or persons who prepared the age model/chronology. The preparers are selected from a pick list and must have been previously entered in the **Contacts** tabsheet.

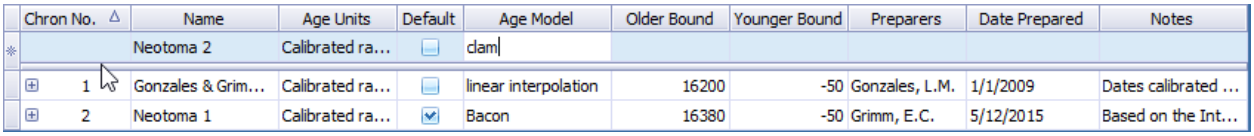
Date Prepared The date the age model/chronology was prepared. The date is selected from a pull down calendar. If only the year is known, 1 January is selected for the day/month. If the month, but not the day is known, the first of the month is selected. The Date Prepared is not necessary for Tilia, but is used in databases.



Notes Any notes about the age model/chronology. The notes appear in a memo box.

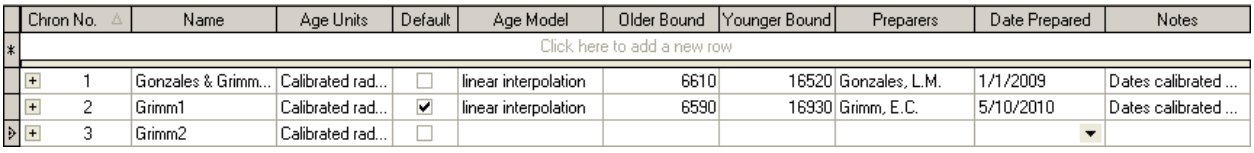


To create a new age model, click in the blank row at the top of the grid indicated by «Click here to add a new row». In the example below, a third age model is being added.



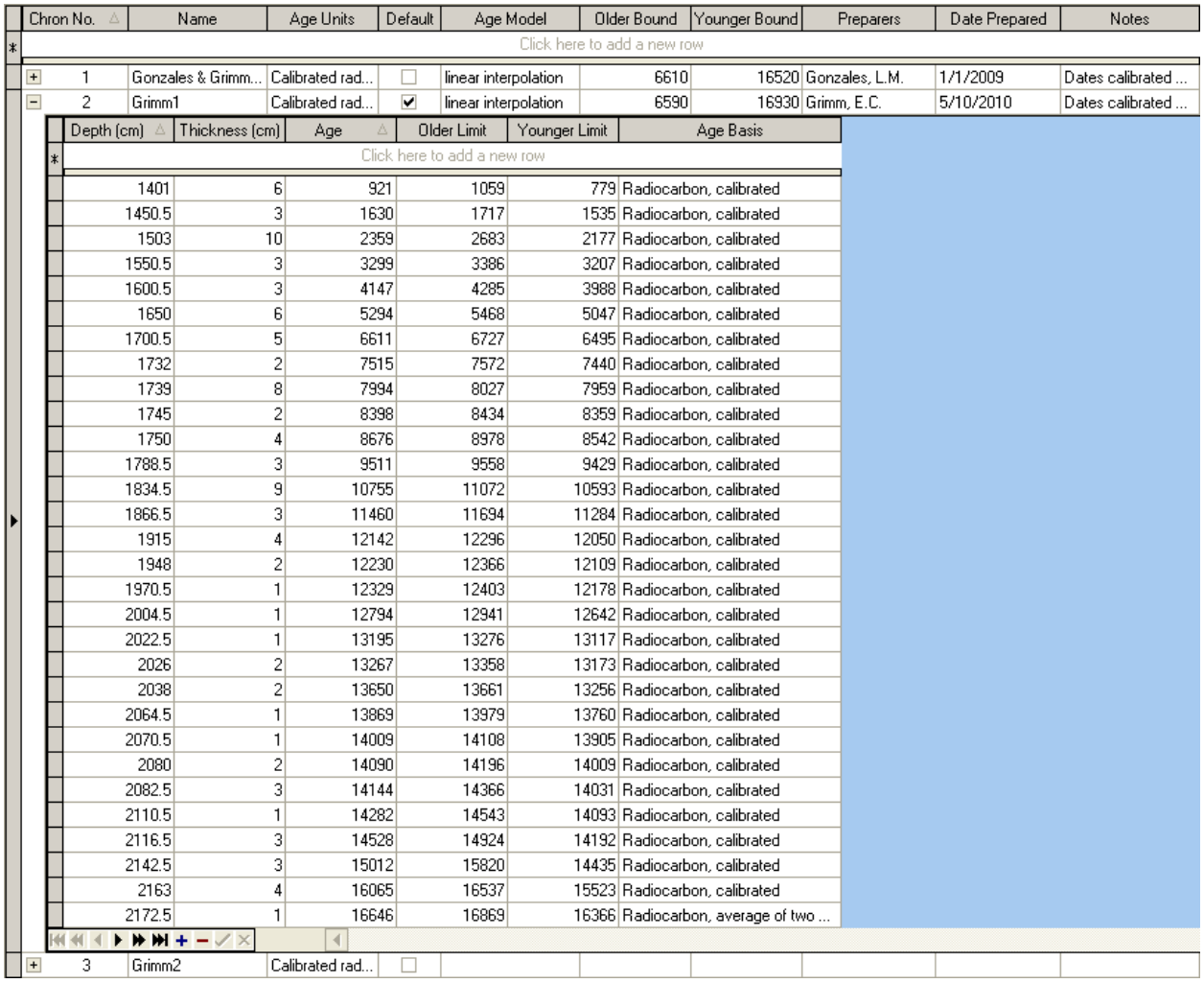
Chron No.	Name	Age Units	Default	Age Model	Older Bound	Younger Bound	Preparers	Date Prepared	Notes
	Neotoma 2	Calibrated ra...	☐	clam					
1	Gonzales & Grim...	Calibrated ra...	☐	linear interpolation	16200	-50	Gonzales, L.M.	1/1/2009	Dates calibrated ...
2	Neotoma 1	Calibrated ra...	☑	Bacon	16380	-50	Grimm, E.C.	5/12/2015	Based on the Int...

Click the green «Post edit» check mark at the bottom of the grid to enter or “post” the new age model.



Chron No.	Name	Age Units	Default	Age Model	Older Bound	Younger Bound	Preparers	Date Prepared	Notes
Click here to add a new row									
1	Gonzales & Grimm...	Calibrated rad...	☐	linear interpolation	6610	16520	Gonzales, L.M.	1/1/2009	Dates calibrated ...
2	Grimm1	Calibrated rad...	☑	linear interpolation	6590	16930	Grimm, E.C.	5/10/2010	Dates calibrated ...
3	Grimm2	Calibrated rad...	☐						

Click the + sign in front of one of the chron numbers to expand the grid of age-depth points or **Chron Controls** for the age model. In the example below, Chron No 2 is expanded.



Chron No.	Name	Age Units	Default	Age Model	Older Bound	Younger Bound	Preparers	Date Prepared	Notes
*	Click here to add a new row								
1	Gonzales & Grimm...	Calibrated rad...	☐	linear interpolation	6610	16520	Gonzales, L.M.	1/1/2009	Dates calibrated ...
2	Grimm1	Calibrated rad...	☑	linear interpolation	6590	16930	Grimm, E.C.	5/10/2010	Dates calibrated ...

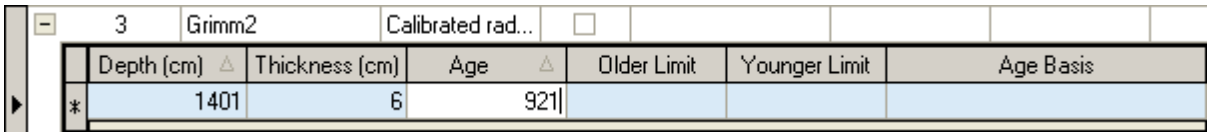
Depth (cm)	Thickness (cm)	Age	Older Limit	Younger Limit	Age Basis
*	Click here to add a new row				
1401	6	921	1059	779	Radiocarbon, calibrated
1450.5	3	1630	1717	1535	Radiocarbon, calibrated
1503	10	2359	2683	2177	Radiocarbon, calibrated
1550.5	3	3299	3386	3207	Radiocarbon, calibrated
1600.5	3	4147	4285	3988	Radiocarbon, calibrated
1650	6	5294	5468	5047	Radiocarbon, calibrated
1700.5	5	6611	6727	6495	Radiocarbon, calibrated
1732	2	7515	7572	7440	Radiocarbon, calibrated
1739	8	7994	8027	7959	Radiocarbon, calibrated
1745	2	8398	8434	8359	Radiocarbon, calibrated
1750	4	8676	8978	8542	Radiocarbon, calibrated
1788.5	3	9511	9558	9429	Radiocarbon, calibrated
1834.5	9	10755	11072	10593	Radiocarbon, calibrated
1866.5	3	11460	11694	11284	Radiocarbon, calibrated
1915	4	12142	12296	12050	Radiocarbon, calibrated
1948	2	12230	12366	12109	Radiocarbon, calibrated
1970.5	1	12329	12403	12178	Radiocarbon, calibrated
2004.5	1	12794	12941	12642	Radiocarbon, calibrated
2022.5	1	13195	13276	13117	Radiocarbon, calibrated
2026	2	13267	13358	13173	Radiocarbon, calibrated
2038	2	13650	13661	13256	Radiocarbon, calibrated
2064.5	1	13869	13979	13760	Radiocarbon, calibrated
2070.5	1	14009	14108	13905	Radiocarbon, calibrated
2080	2	14090	14196	14009	Radiocarbon, calibrated
2082.5	3	14144	14366	14031	Radiocarbon, calibrated
2110.5	1	14282	14543	14093	Radiocarbon, calibrated
2116.5	3	14528	14924	14192	Radiocarbon, calibrated
2142.5	3	15012	15820	14435	Radiocarbon, calibrated
2163	4	16065	16537	15523	Radiocarbon, calibrated
2172.5	1	16646	16869	16366	Radiocarbon, average of two ...

3	Grimm2	Calibrated rad...	☐						

You may enter Chron Controls manually or import them from the Geochronology tabsheet.

Manual Entry of Chron Controls

To enter a new Chron Control, click in the blank row at the top of the grid indicated by «Click here to add a new row».



3	Grimm2	Calibrated rad...	☐						

Depth (cm)	Thickness (cm)	Age	Older Limit	Younger Limit	Age Basis
*	1401	6	921				

The fields are:

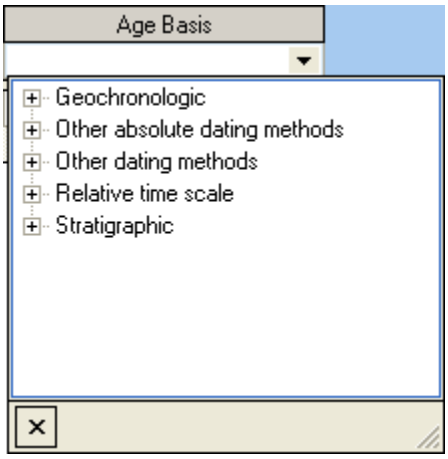
Depth (cm) Midpoint depth of the Chron Control in cm.

Thickness (cm) Thickness of Chron Control in cm. Most Chron Controls are from a section of sediment. Two pieces of data are required: either the top and bottom depths of the section, or, in this case, the midpoint and thickness of the section.

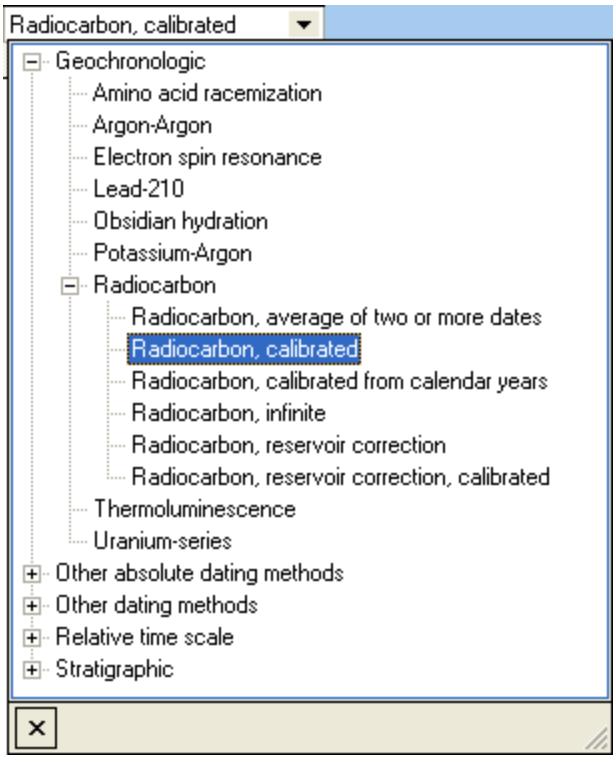
Age Age control value

Older Limit Older confidence limit of the age control. For radiocarbon ages, the limits would ordinarily be the 2σ or 95% confidence limits.

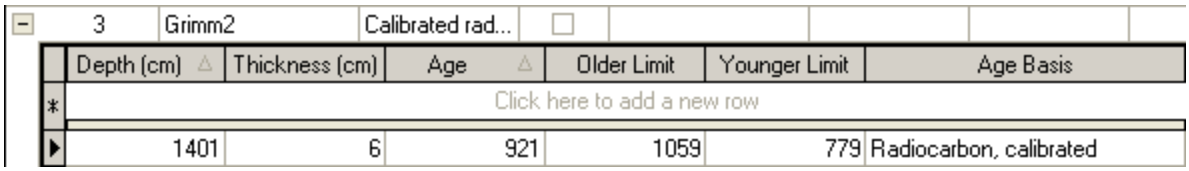
Age Basis The type of age control, e.g. a calibrated radiocarbon age. A large number of age control types exist, and these are selected from an expandable pick list, organized by type. These controls are read from an external lookup file and can be edited or supplemented.



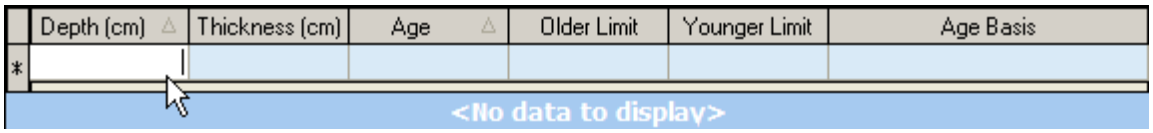
In the example below, «Geochronologic» age control «Radiocarbon, calibrated» has been selected.



Click the post edit ✓ button at the bottom of the grid to post the new Chron Control.



The Chron Control data may be pasted from an Excel worksheet or from another age-model grid. After copying the data to the clipboard, click the left most cell in the data entry line. Paste the data with Ctrl+V or the Edit→Paste menu selections.



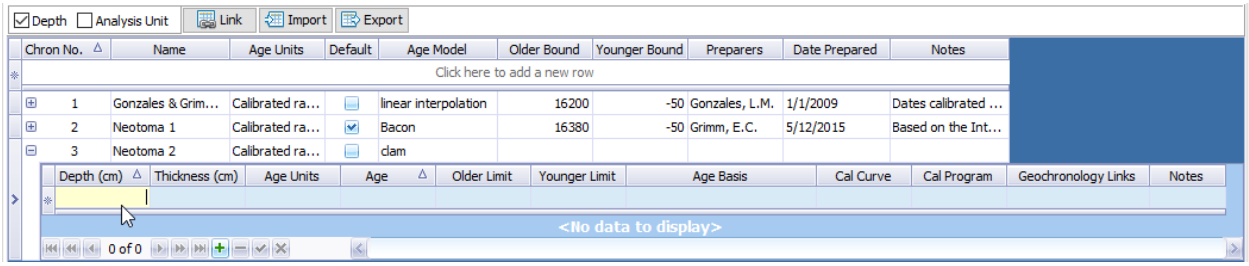
Chron Control data may be copied from another Chron Control grid by highlighting the desired cells with the mouse and copying with Ctrl+C or the Edit > Copy menu selections.

In some cases, different age models will use the same Chron Controls, but use different algorithms for assigning sample ages; in which case, copying and pasting is highly efficient.

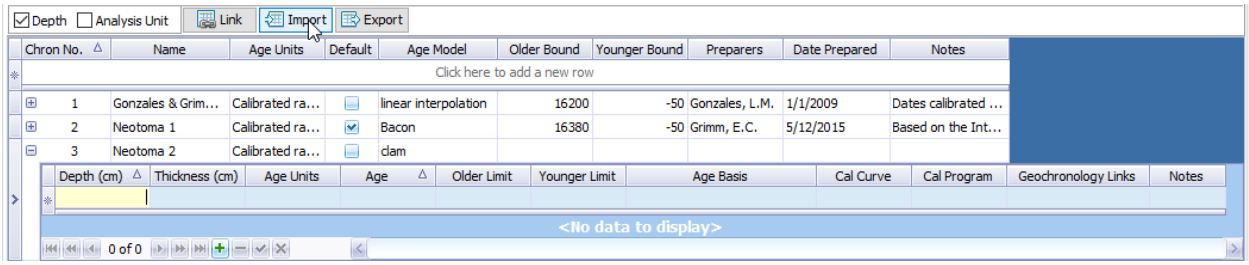
Note: For Tilia to generate a chronology, the only data required are Depth (cm) and Age. The other fields are used for databases.

Importing Chron Controls

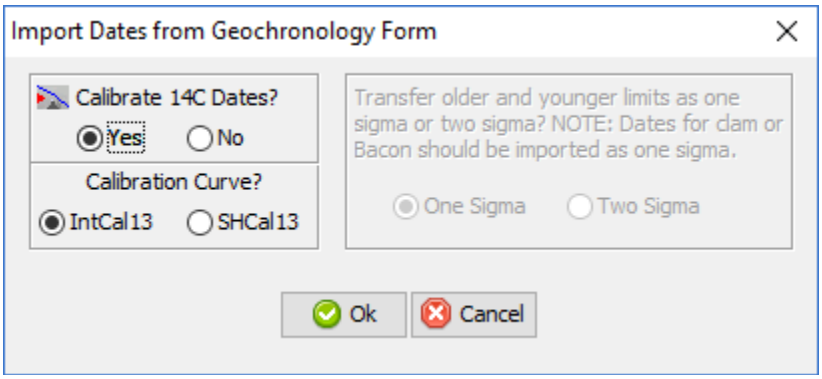
Click the + sign in front of the chronology to open the Chron Controls grid and click on any cell in the new row line. Click the import button above the Chronologies grid



Click the **Import** button above the grid.



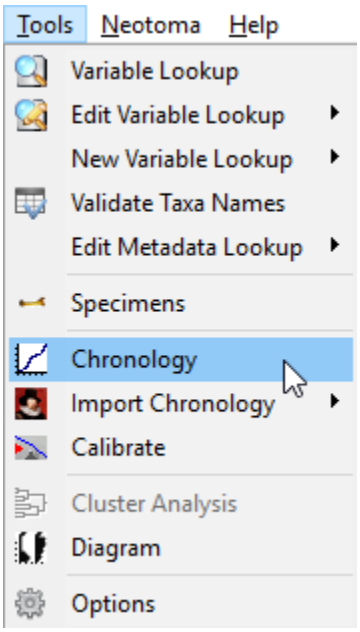
Radiocarbon dates in the Geochronology tabsheet may be imported uncalibrated or calibrated. If **Yes** is selected for **Calibrate 14C dates**, the **Calibrate Curve?** box will be enabled. Select the Northern Hemisphere IntCal13 or Southern Hemisphere SHCal13 curve. The radiocarbon dates will be imported from the Geochronology tabsheet and calibrated with OxCal.

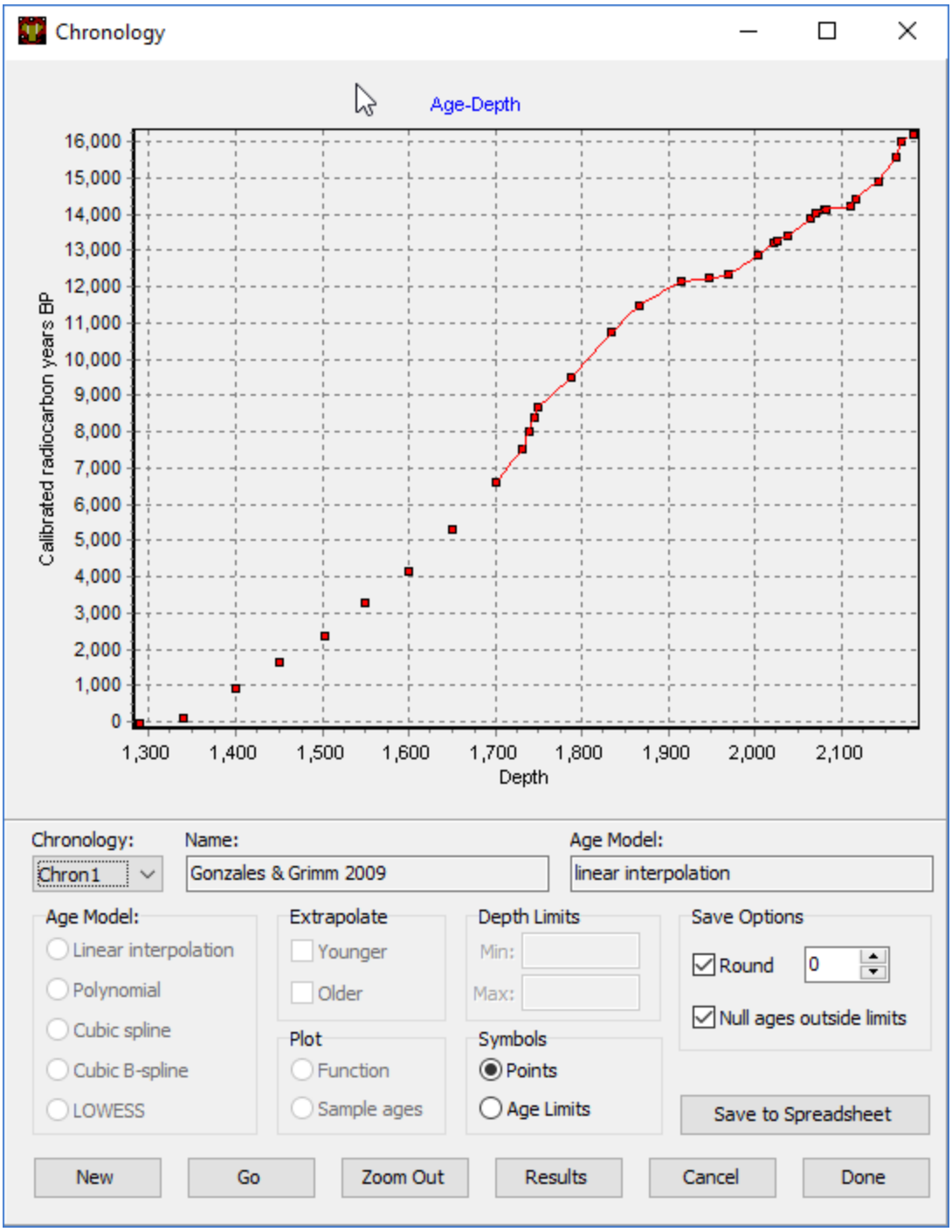


If **No** is selected for **Calibrate 14C dates**, they can be imported with one or two sigma errors. If importing for a clam or Bacon age model, import with one sigma. If importing for a classic age model to be created by Tilia, the error will not be used, so it doesn't matter which one is selected; however, the errors can be shown on age-depth graph to judge the adequacy of the age model.

Creating a Chronology from an Age Model

Tilia can create chronologies from data in the Age Model tabsheet. Click the **Tools→Chronology** menu selections:





When first opened, the **Chronology** form shows the first chronology. The graph shows the Chron Controls as symbols. If a companion chronology is present in the spreadsheet, the sample ages are shown as a line graph. Although a chronology can be entered in the spreadsheet and used for an age scale in a diagram, an age model must be entered in the Age Model tabsheet in order for the chronology to be shown on the Chronology form. In this example, there are several Chron Controls (calibrated radiocarbon ages) above the first pollen sample. Except for the Chronology pick list, other controls are disabled. To create a new age model/chronology, click the **New** button, which will enable the other

controls. There is no harm in experimenting with new age models as nothing is saved to the spreadsheet until the **Save to spreadsheet** button is clicked.

Controls:

Chronology Select the Chronology from the pick list, which lists the Chron No's in the Age Model tabsheet.

Name Name of the chronology

Age Model Age model algorithm. If a new age model is created, this item will be changed accordingly and will be written to the Age Model tabsheet. An age-model algorithm selected from the radio button box will be written to the edit box in the upper right. After the radio button is clicked, the name may be edited.

Extrapolate Check the appropriate box to extrapolate beyond the younger/older Chron Control. Ages will be extrapolated to the youngest/oldest depth in the spreadsheet.

Depth Limits Enter optional Min/Max depth values for the age model. It is possible to create a complex age model by selecting appropriate Min/Max values for different algorithm and merging them in the spreadsheet.

Plot Plot either the function (as a series of evenly spaced points) or the actual sample ages.

Symbols Plot the symbols for Chron Controls as either points (square boxes) or pairs of rectangles indicating the older/younger limits.

Save Options Check **Round** to round the assigned ages to the number of decimal points indicated (zero by default). Check **Null ages outside limits** to assign null values to ages outside the Depth Limits.

Buttons:

New Enable the controls to create a new age model

Go Create the new age model based on the selections made

Zoom Out Zoom the graph out. Zoom in by selecting a rectangle with the mouse.

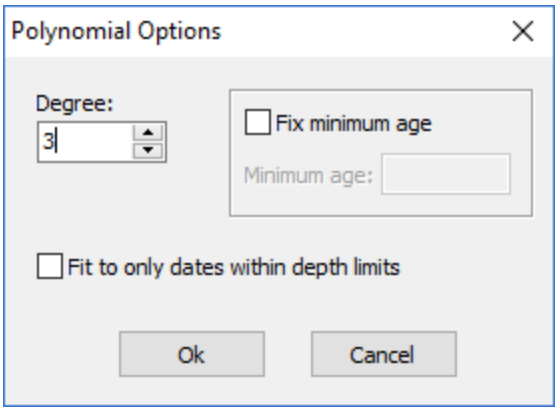
Cancel Cancel everything and close the form.

Done Finished with the age model form. If results have not been saved to spreadsheet, acts as Cancel.

Results Opens a new form with a grid showing the assigned depths and ages. Useful for copying and pasting the results to other spreadsheets or for closely examining the results. If the polynomial age model is selected, the function will also be shown.

Save to Spreadsheet Save results to the spreadsheet. Nothing is changed or saved to the spreadsheet or age model tabsheet until this button is clicked. If the matching Chron code is present in the spreadsheet, the ages will be written to that row; otherwise a new row is inserted.

The **Polynomial** and **LOWESS** age models require additional options, which will be requested when the **Go** button is clicked. Here are the polynomial options:

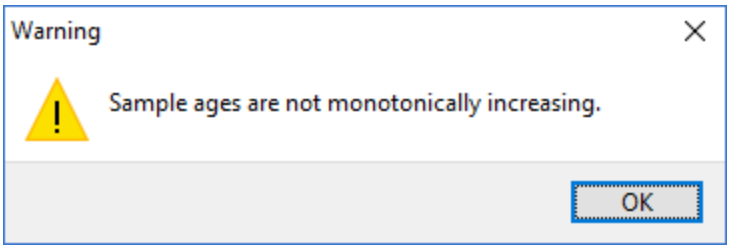


Degree Degree or order of the polynomial. A degree of 1 is a straight line or linear fit.

Fix minimum age Fix the minimum age of the fitted polynomial (at the minimum depth), which often is known exactly (e.g. the date the core was collected). By default the minimum age will be the Chron Control with the youngest age.

Fit to only dates within depth limits Normally the polynomial is fitted to all the Chron Controls. If this box is checked, only the Chron Controls between the Depth Limits will be used.

Any of the age-model algorithms can produce ages that are not monotonically increasing with depth, which normally is not an acceptable age model. If this happens, a warning will appear after **Go** is clicked.



In some cases, the function is not monotonically increasing, but the interpolated sample ages are. In which case, the following error message appears. The user can decide whether this age model is acceptable or not.