
9000

All deglacial model-data comparisons are wrong Some may be useful

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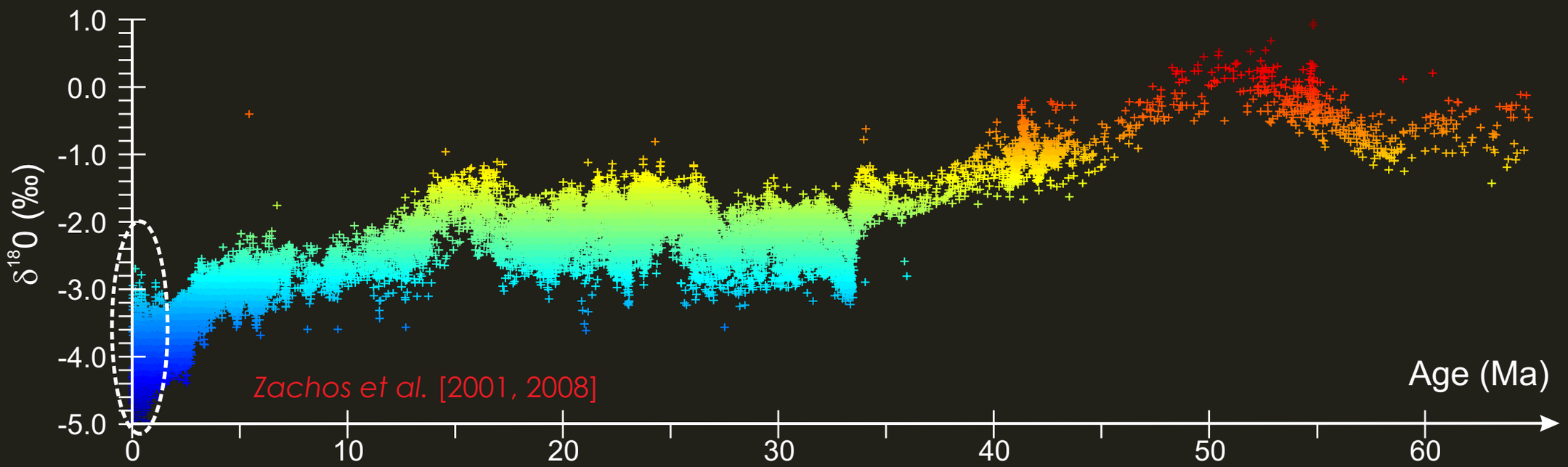
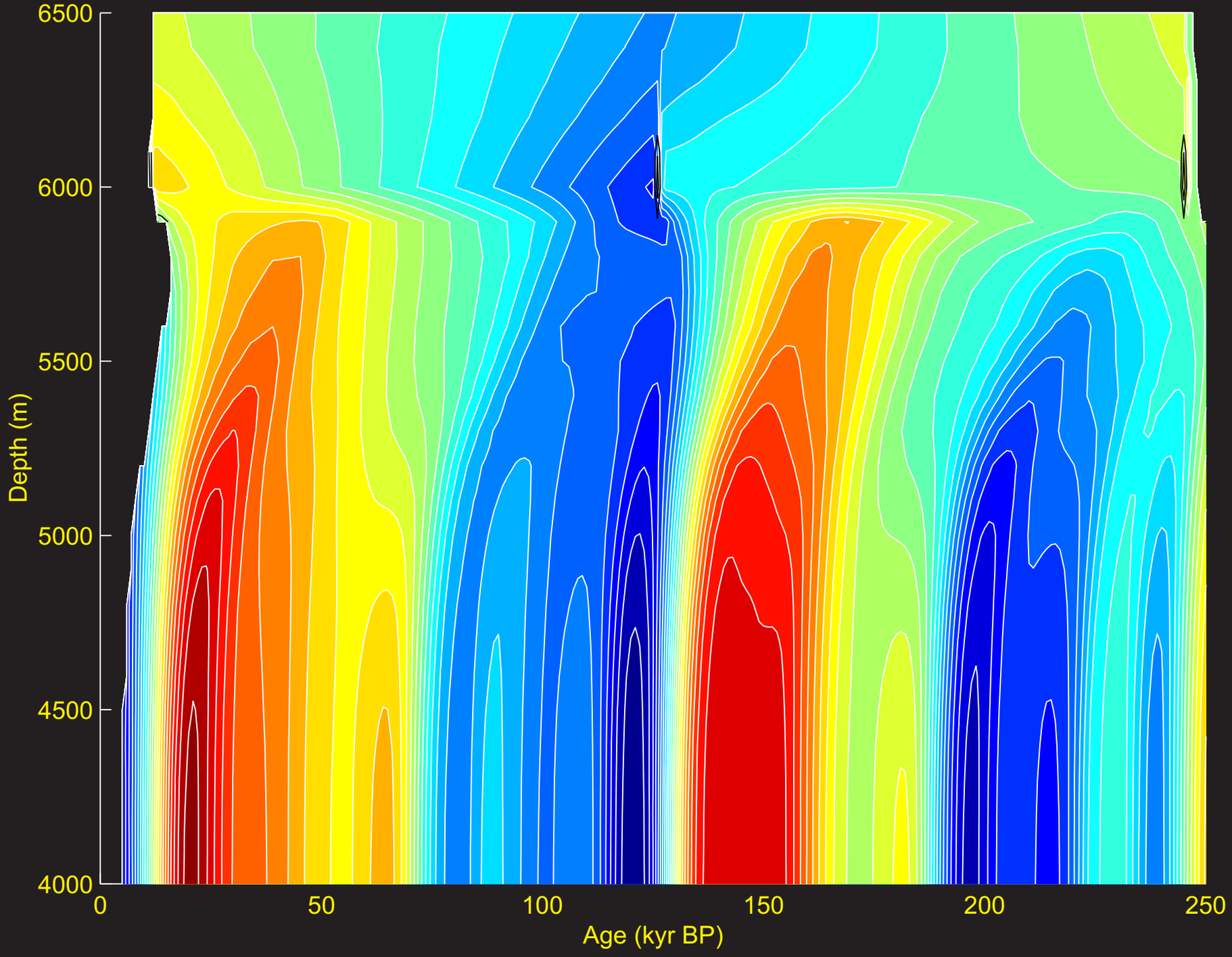
University of Bristol / University of California, Riverside

European Research Council
Established by the European Commission

Outline of talk



Outline of talk



Anticipated outcome of talk

One (or more) of the following:

- This is not relevant at all.
- Too late – this was relevant 15 years ago.
- There are potentially important implications for bulk carbonate and low sedimentation rate records.
  But no-one in their right mind uses these any more.

forget about it
drink beer
be happy

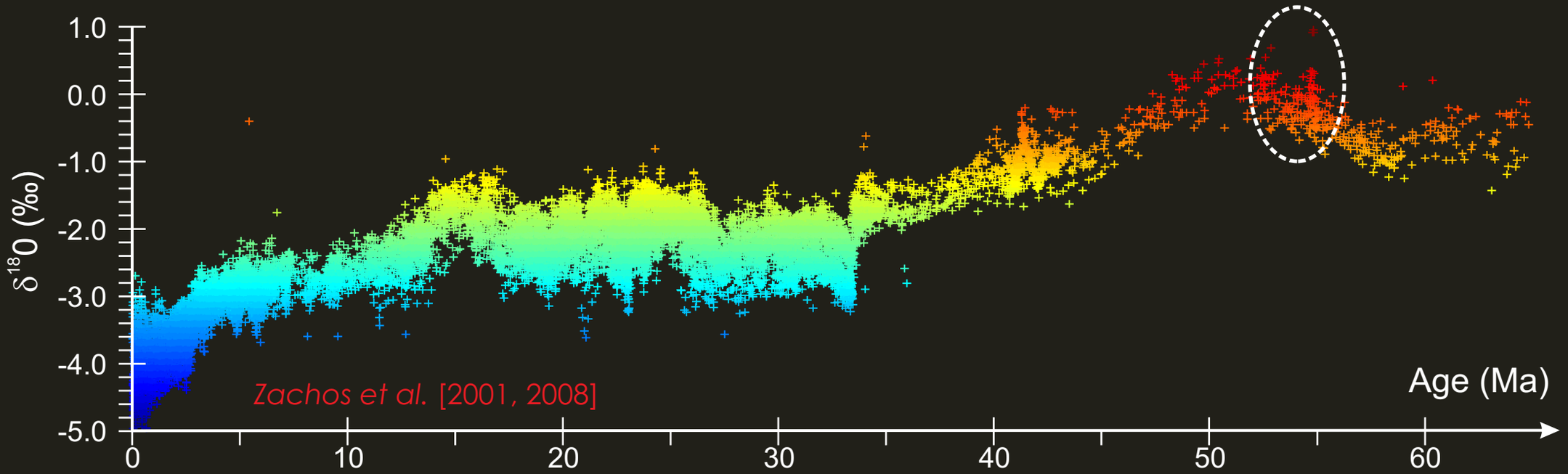
- There are important implications for data-data (wiggle matching) and model-data analysis.
- There are important questions raised of where in the sediments, and what fraction, of carbonate dissolves.

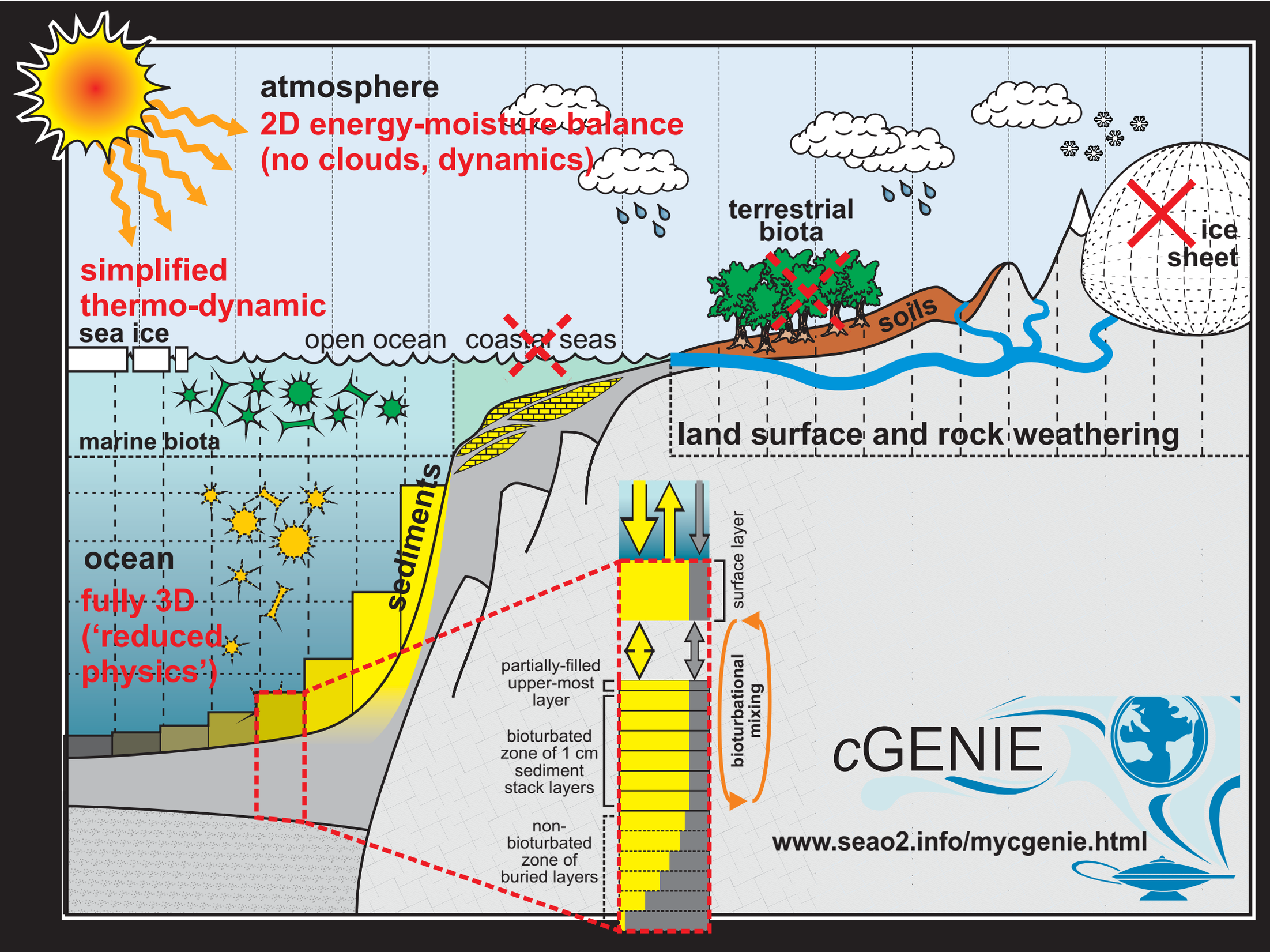
keep going

- Meh

meh

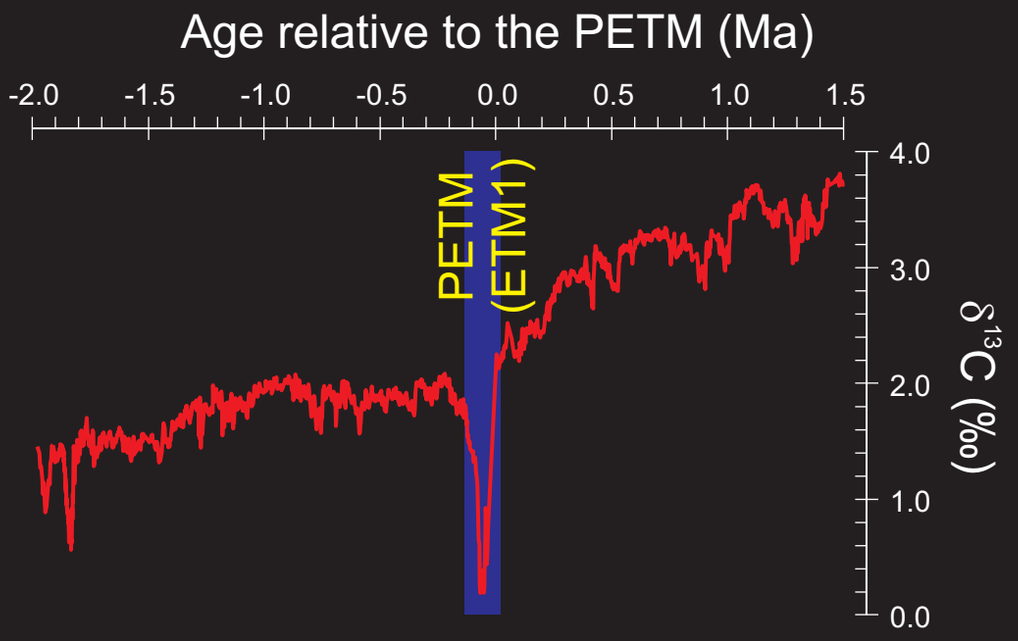
A deep time perspective on shallow time, time




atmosphere
2D energy-moisture balance
(no clouds, dynamics)
simplified
thermo-dynamic
sea ice
open ocean
coastal seas
terrestrial
biota
soils
ice
sheet
marine biota
land surface and rock weathering
sediments
ocean
fully 3D
('reduced
physics')
surface layer
partially-filled
upper-most
layer
bioturbated
zone of 1 cm
sediment
stack layers
non-
bioturbated
zone of
buried layers
bioturbational
mixing
cGENIE
www.seao2.info/mycgenie.html

Age model artifacts -- lessons from deeper-time (1)

Consider: An event characterized by a (severe) reduction in carbonate preservation



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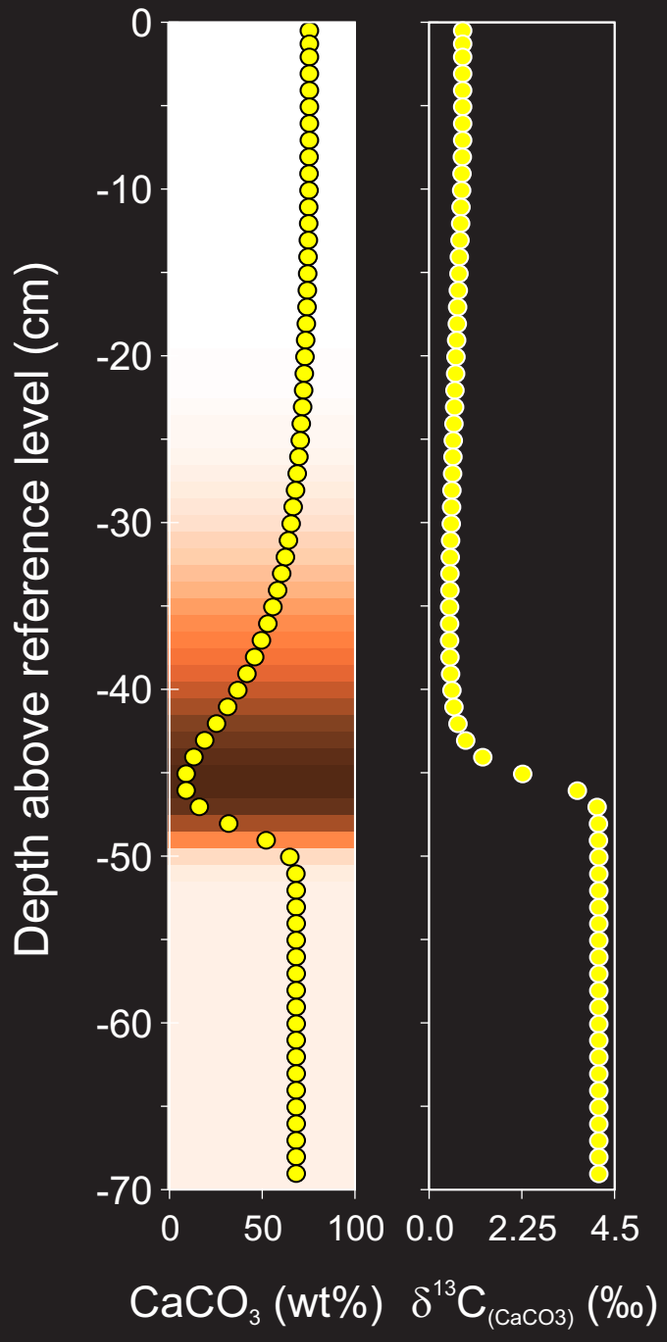


?

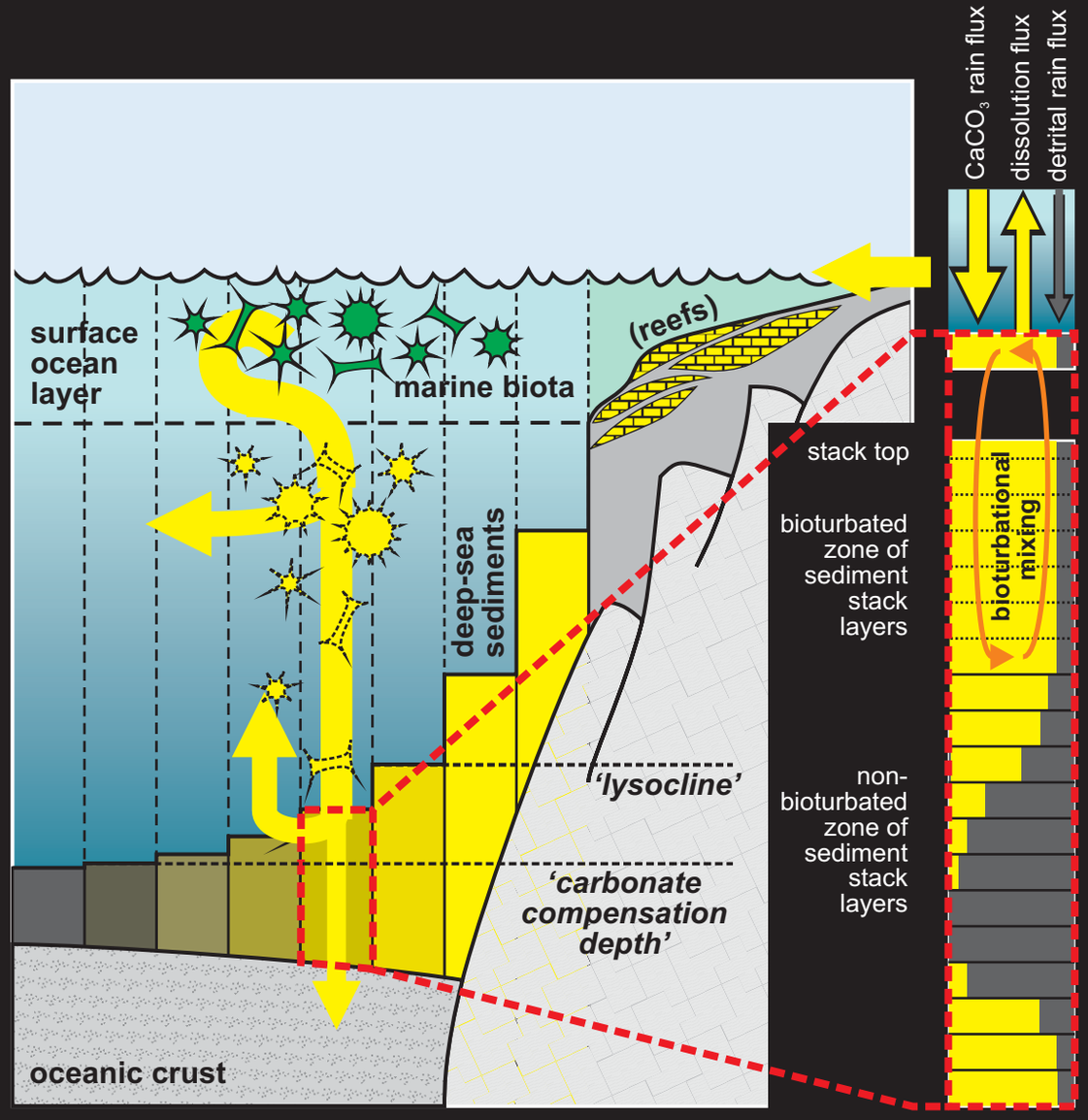
(model-data divide)

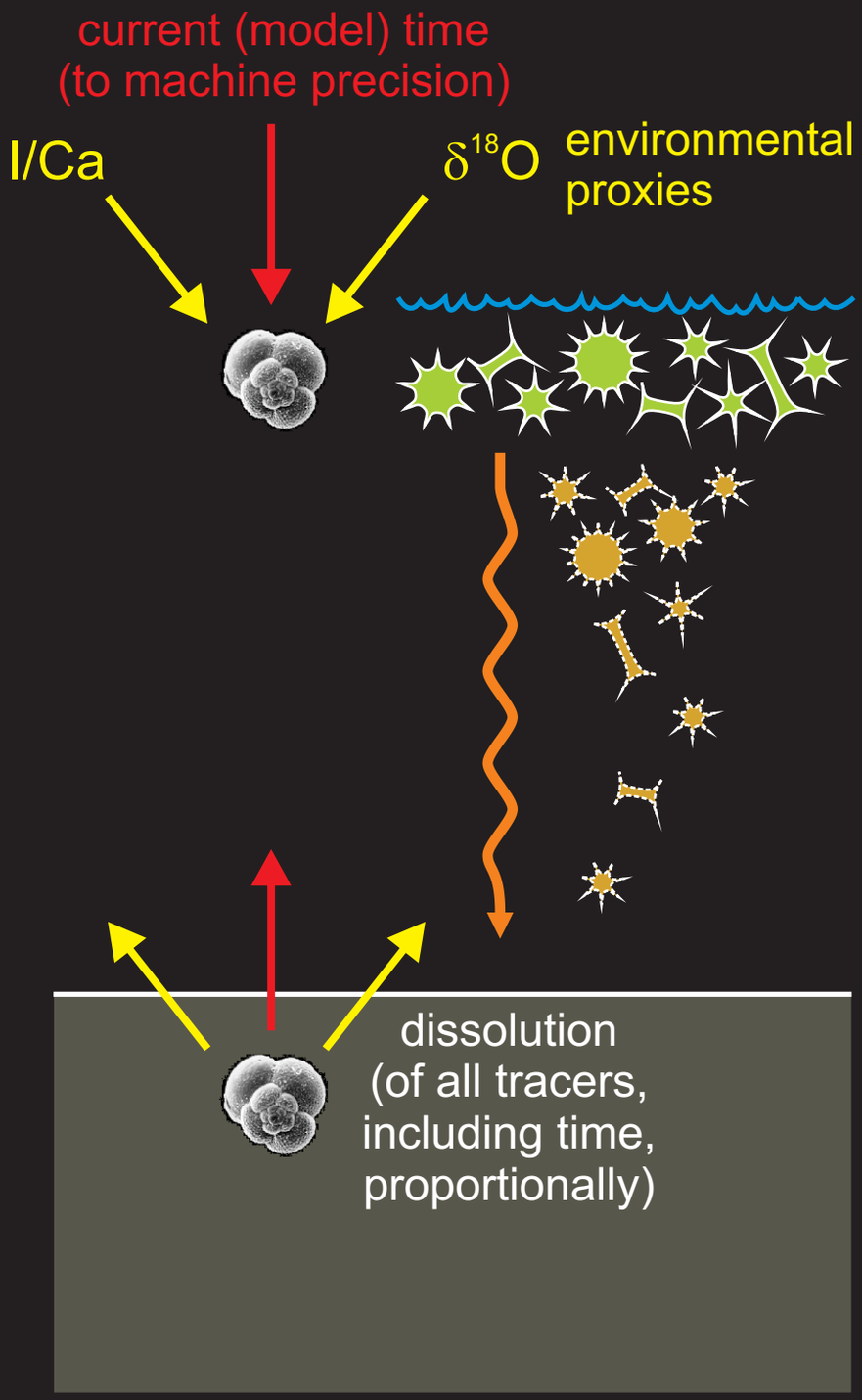
numerical model time-series or external (to ocean) record (e.g. ice core)

low high

pCO_2 (µatm)

Age model artifacts -- lessons from deeper-time (1)





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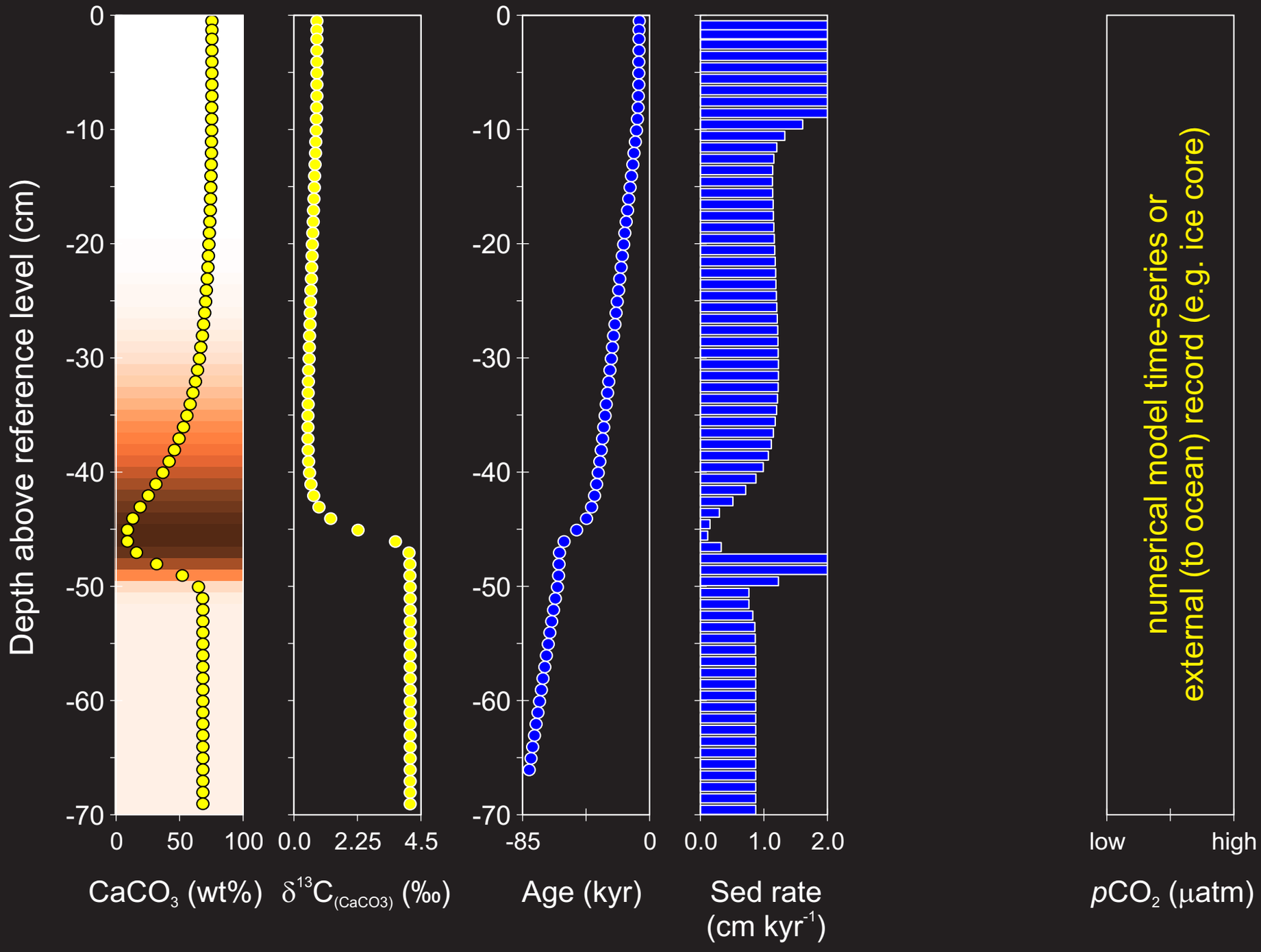

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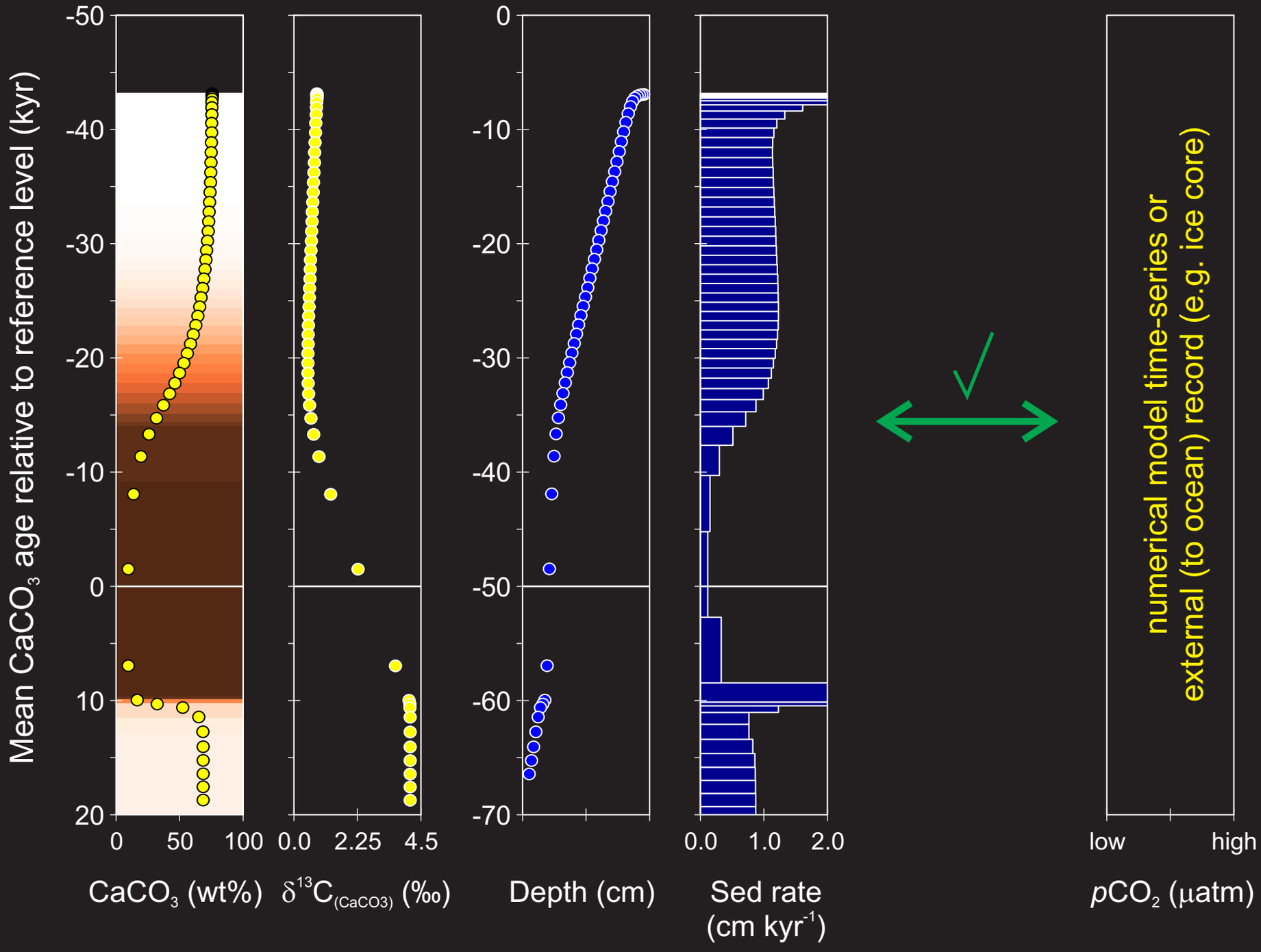

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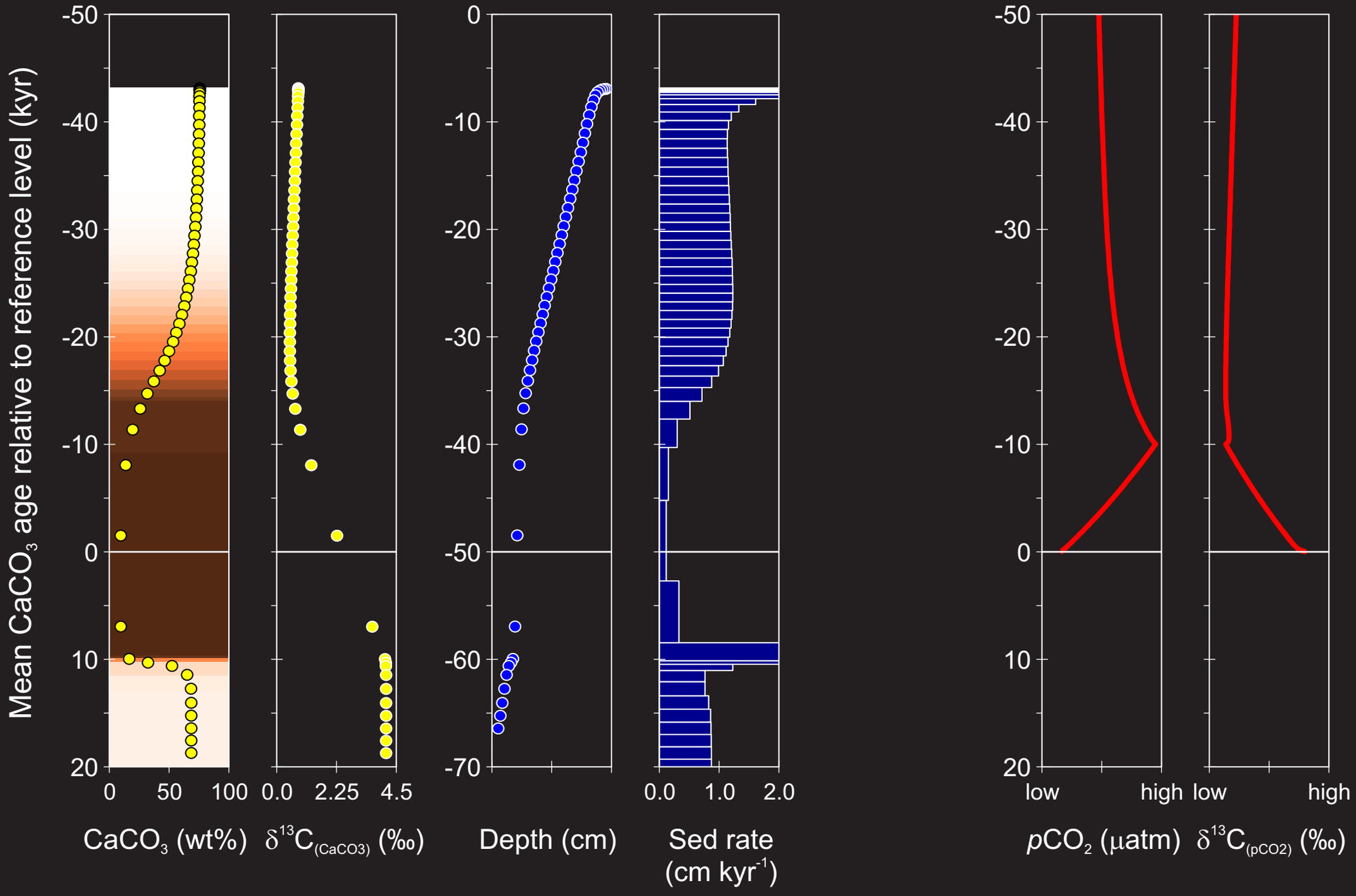

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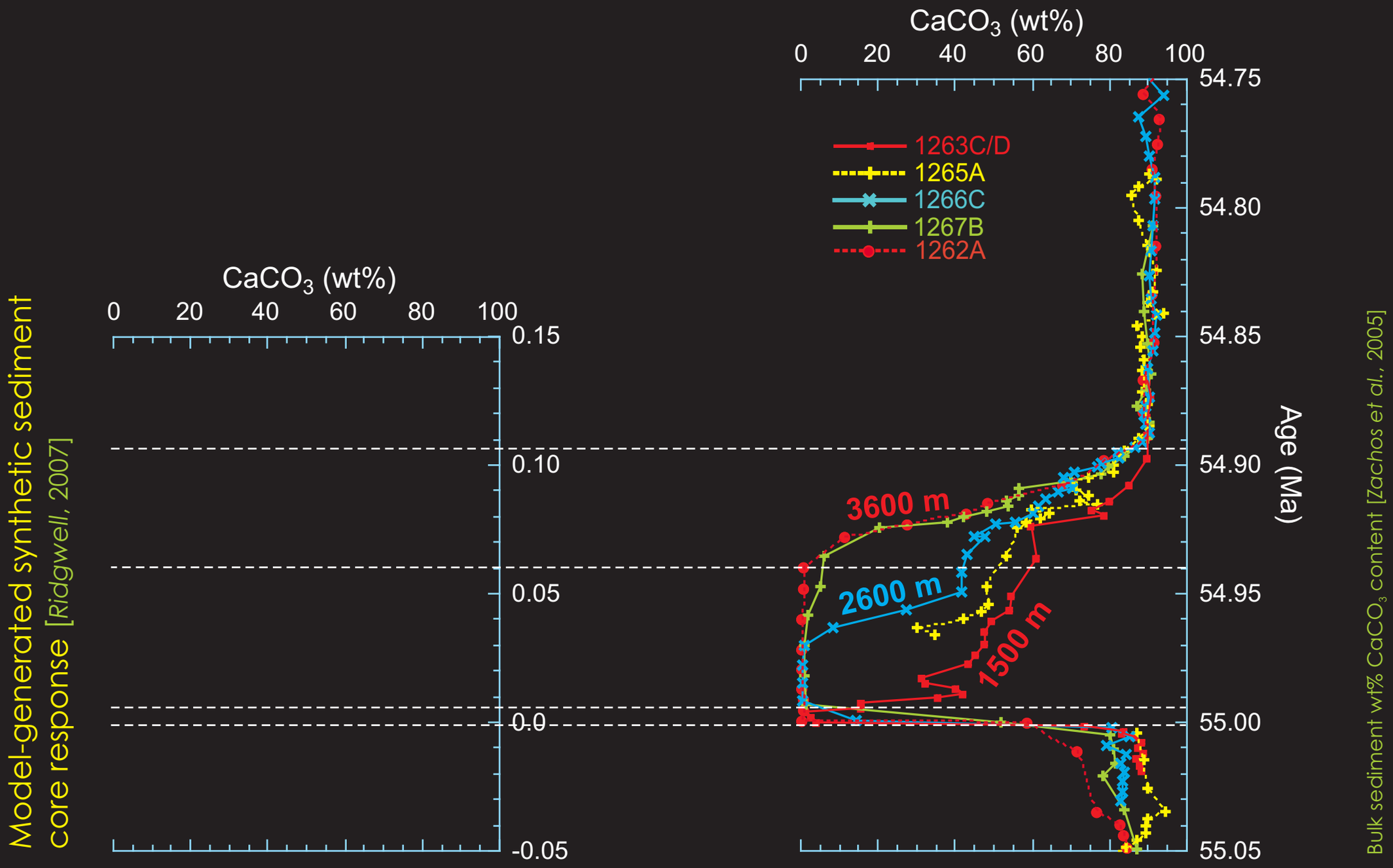

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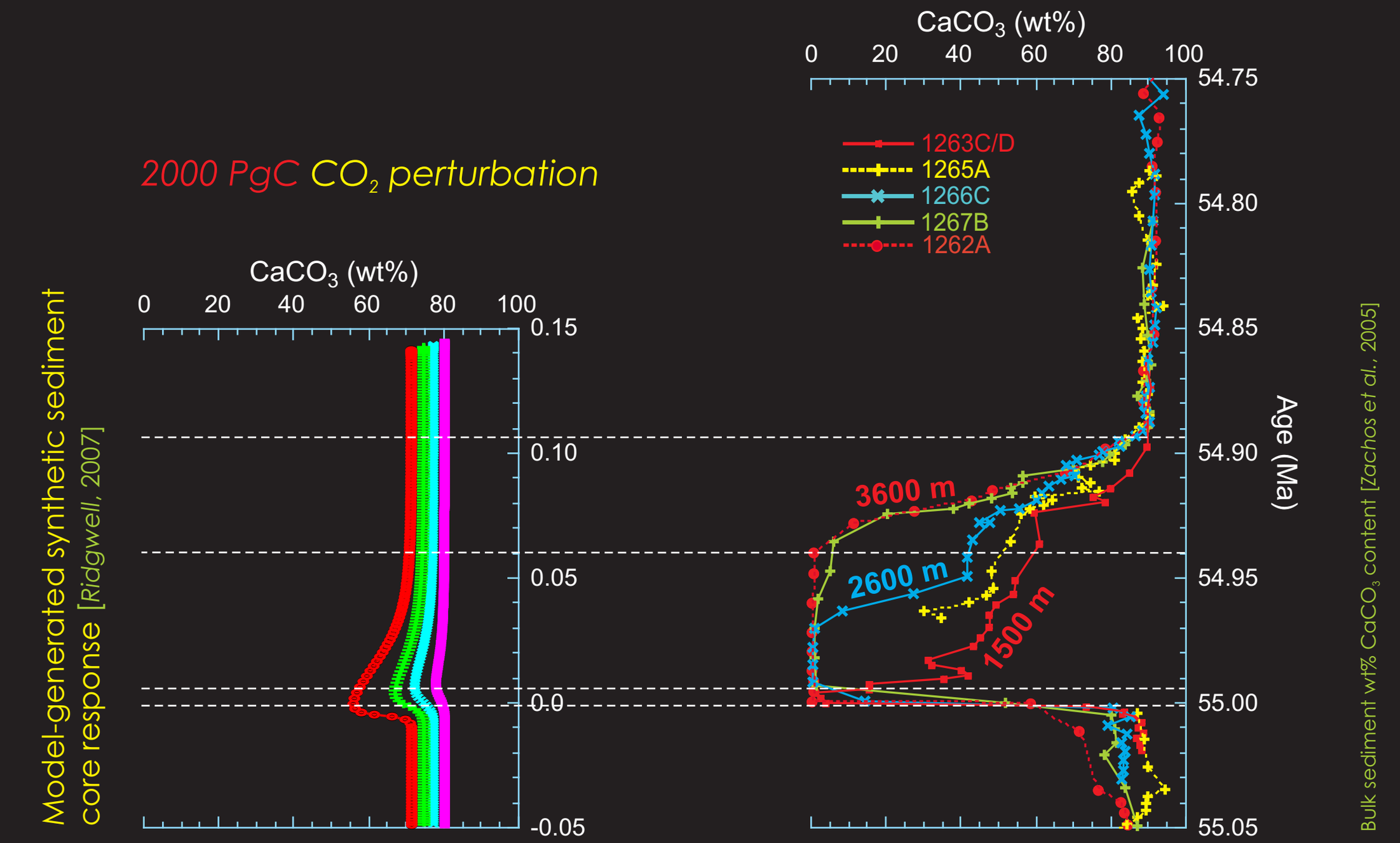

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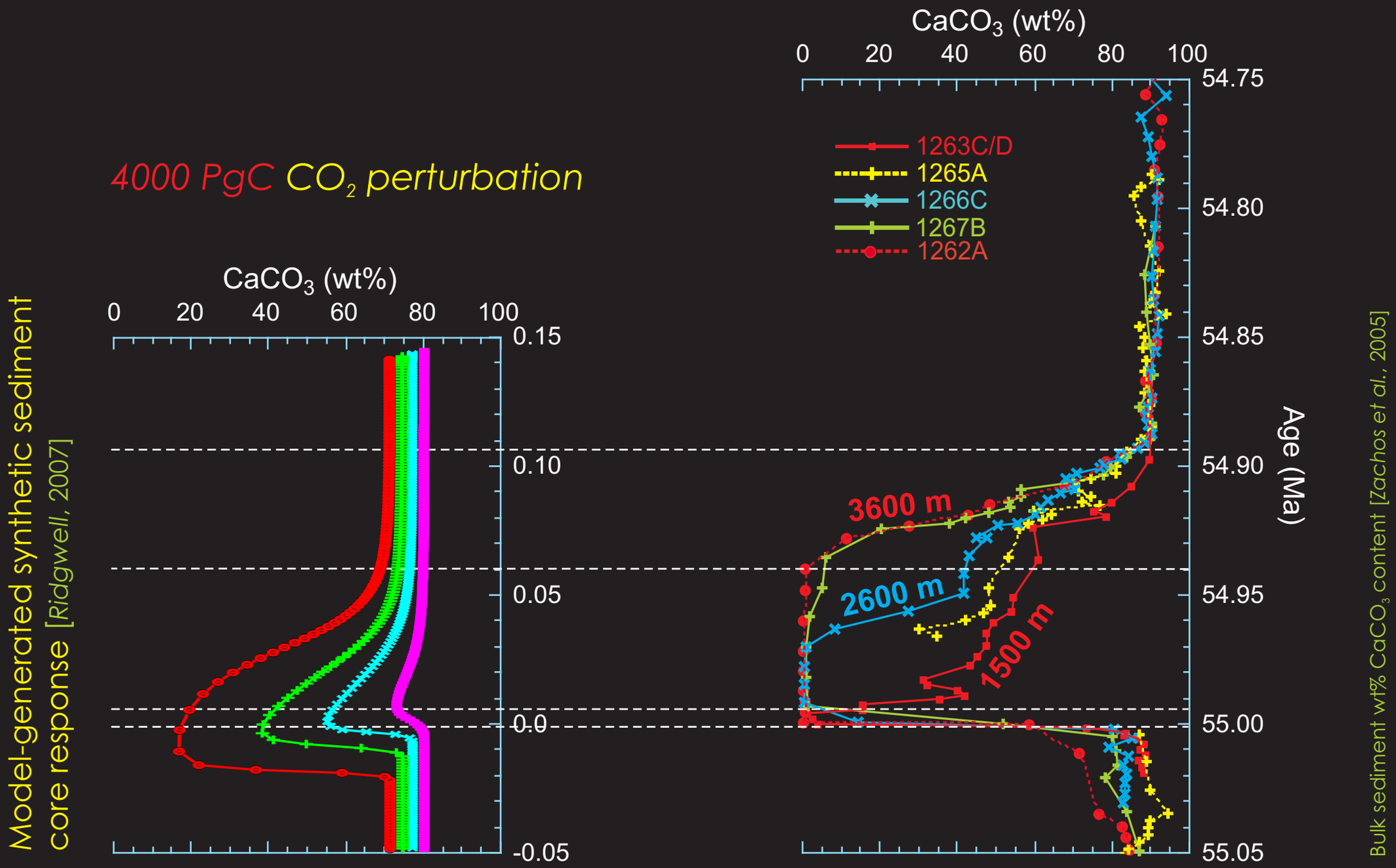

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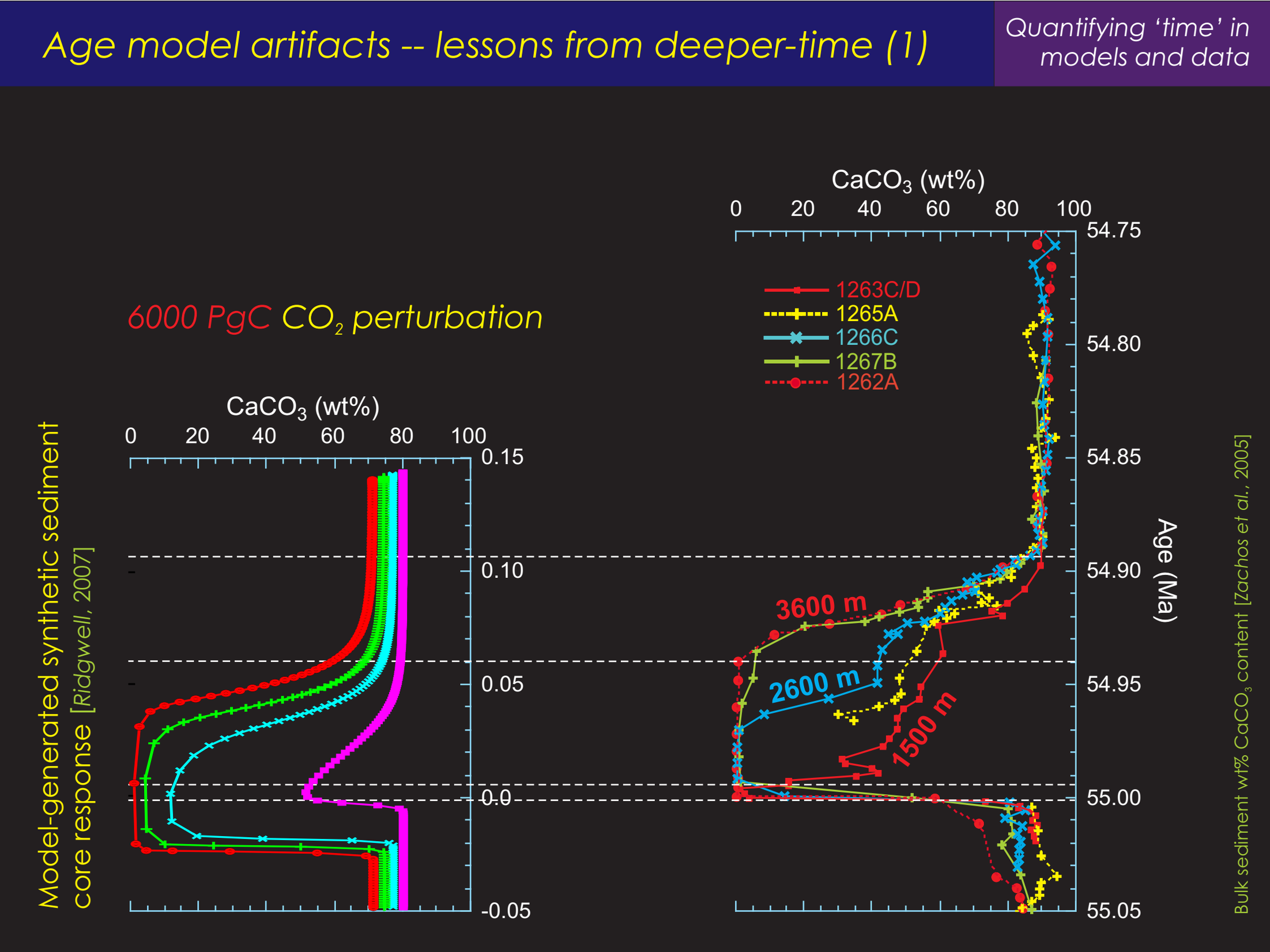
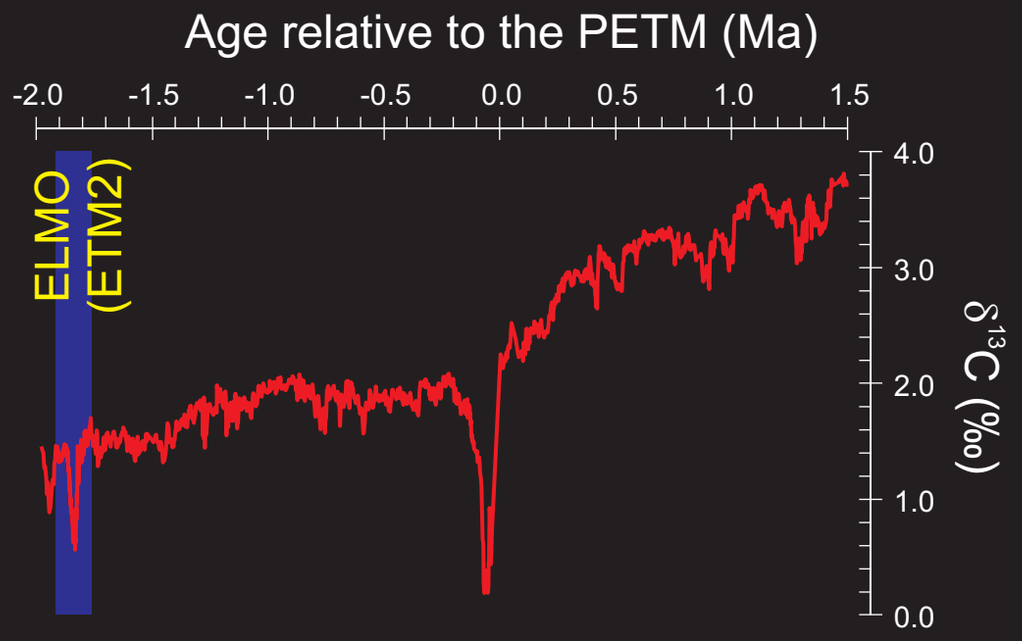
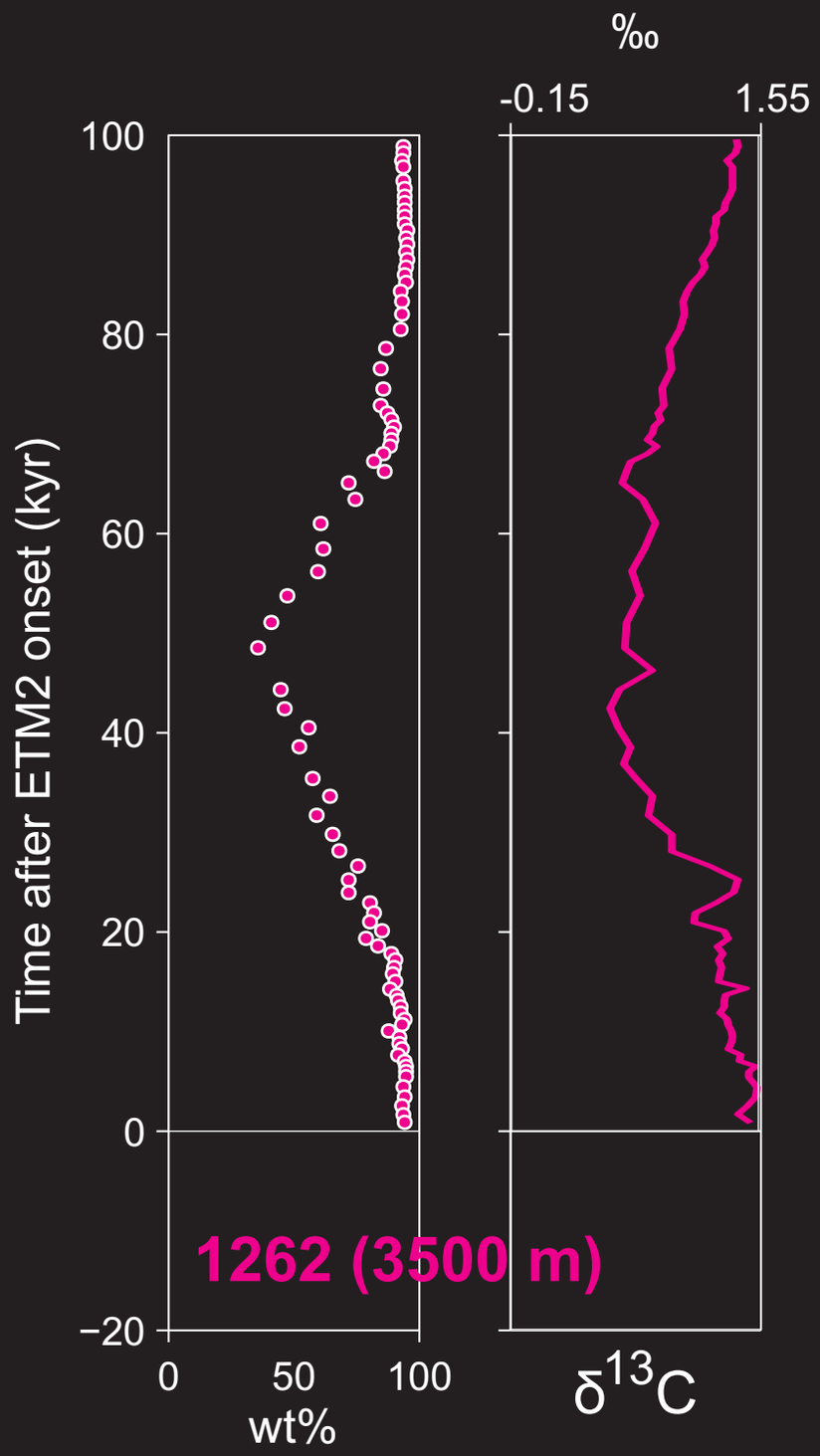


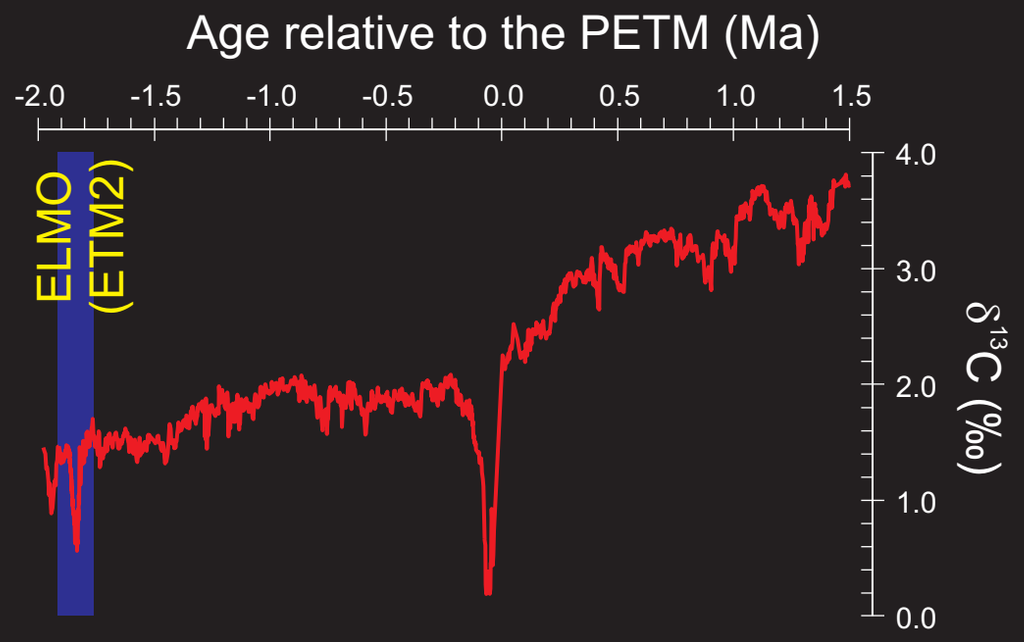
Age model artifact lessons from deeper-time (2)

Consider: An event characterized by a (mild) reduction in carbonate preservation



Age model artifact lessons from deeper-time (2)





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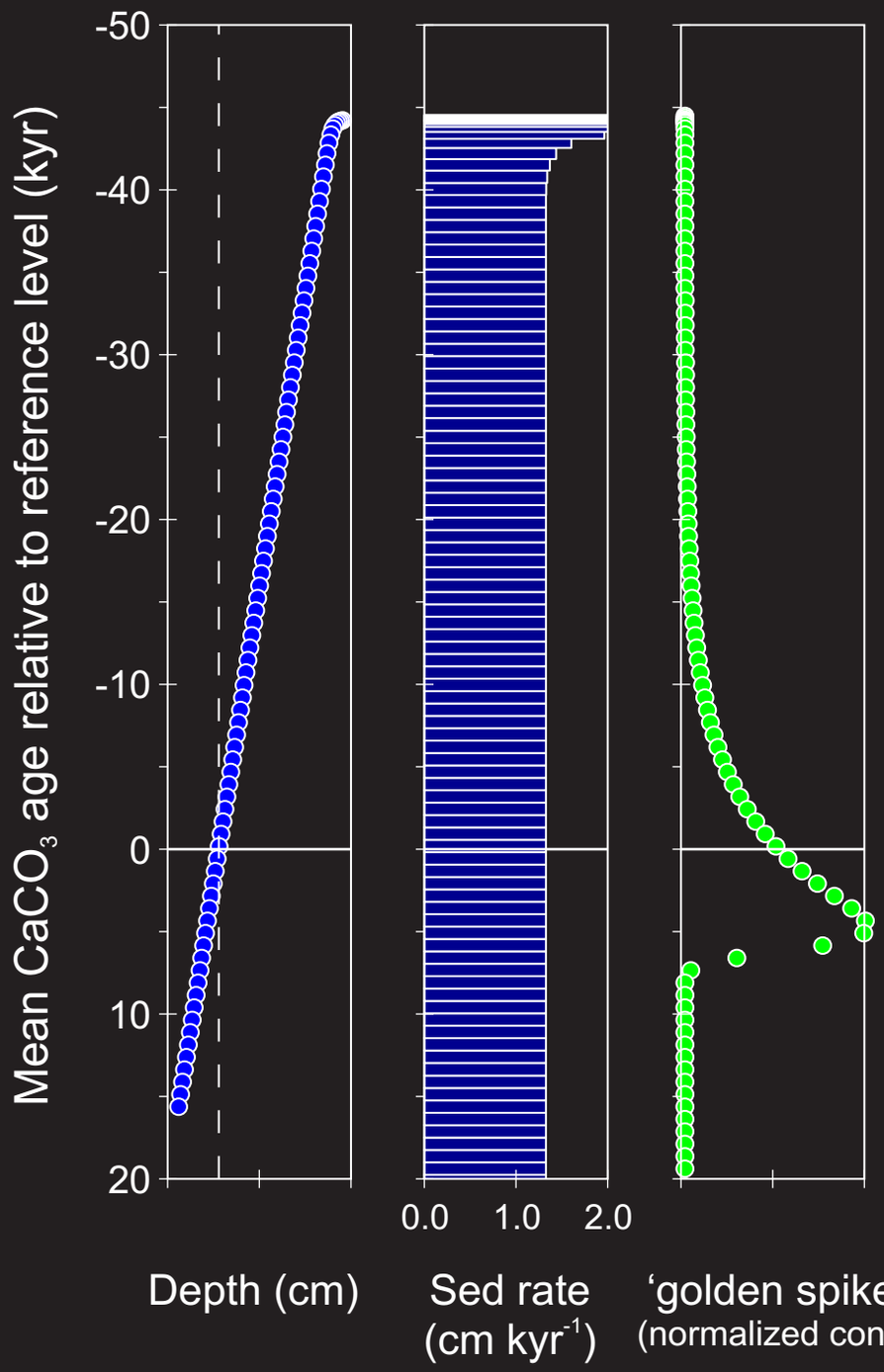
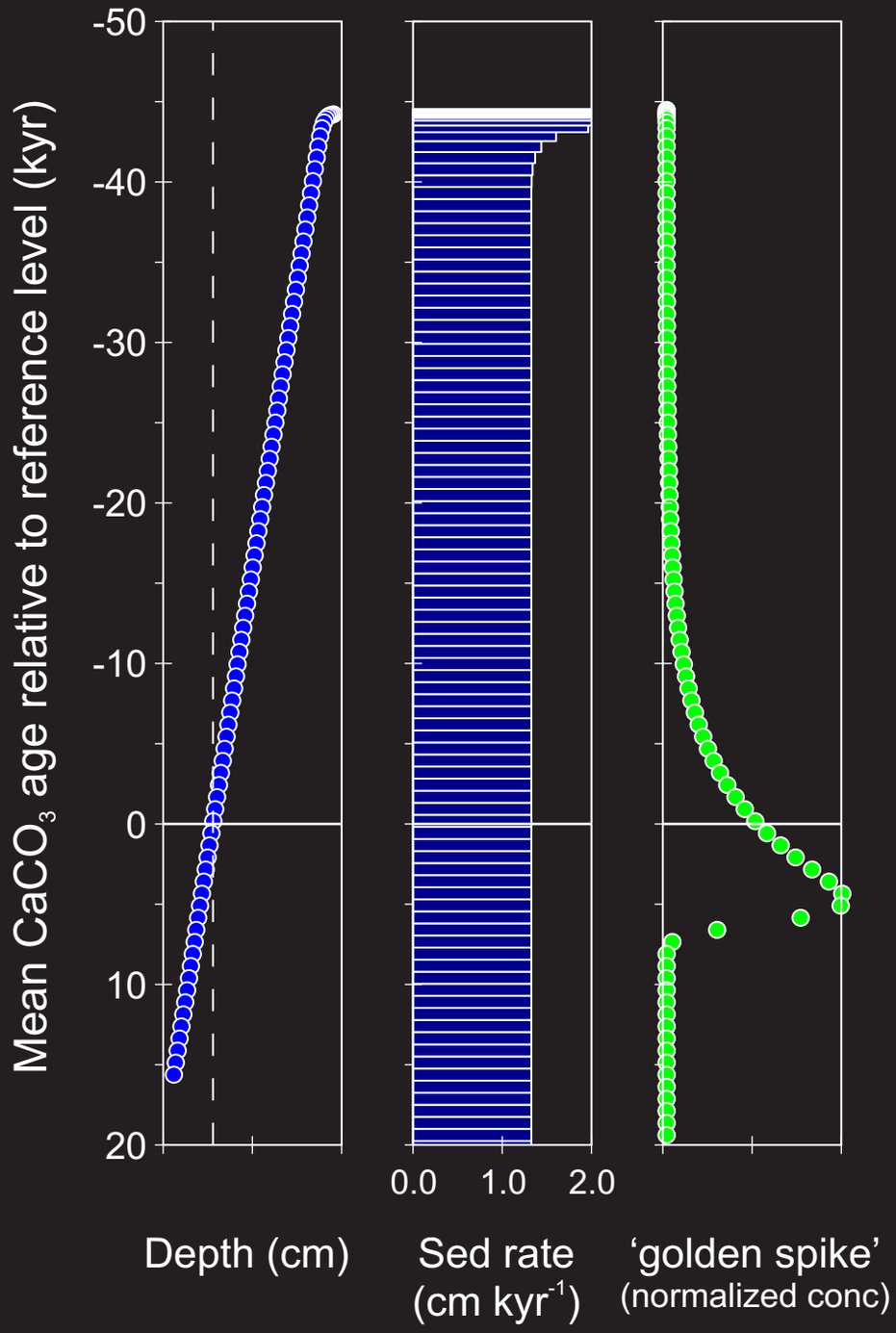
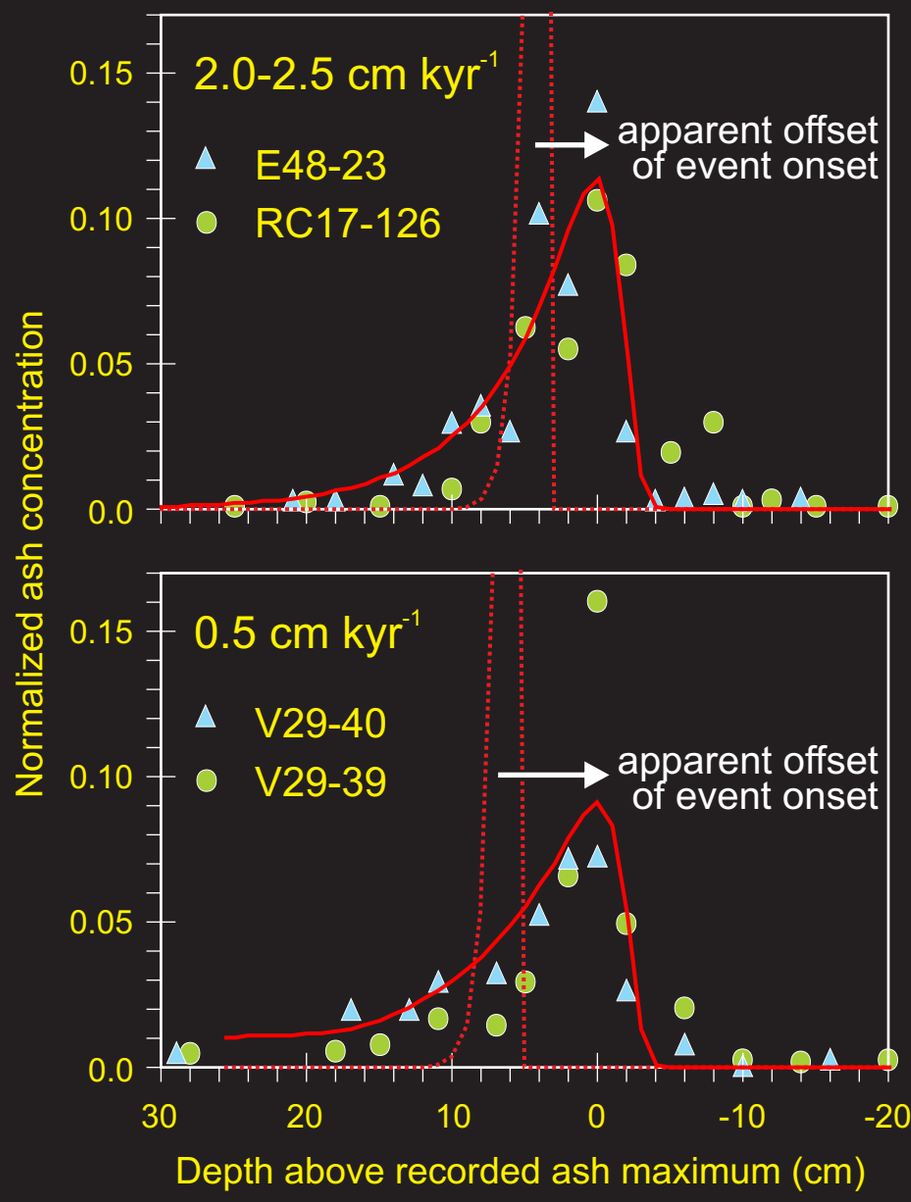


model experiment starts,
surface sediments 'tagged'
(instantaneous pulse of inert,
conservative, numerical tracer)

Age model artifact lessons from deeper-time (2)





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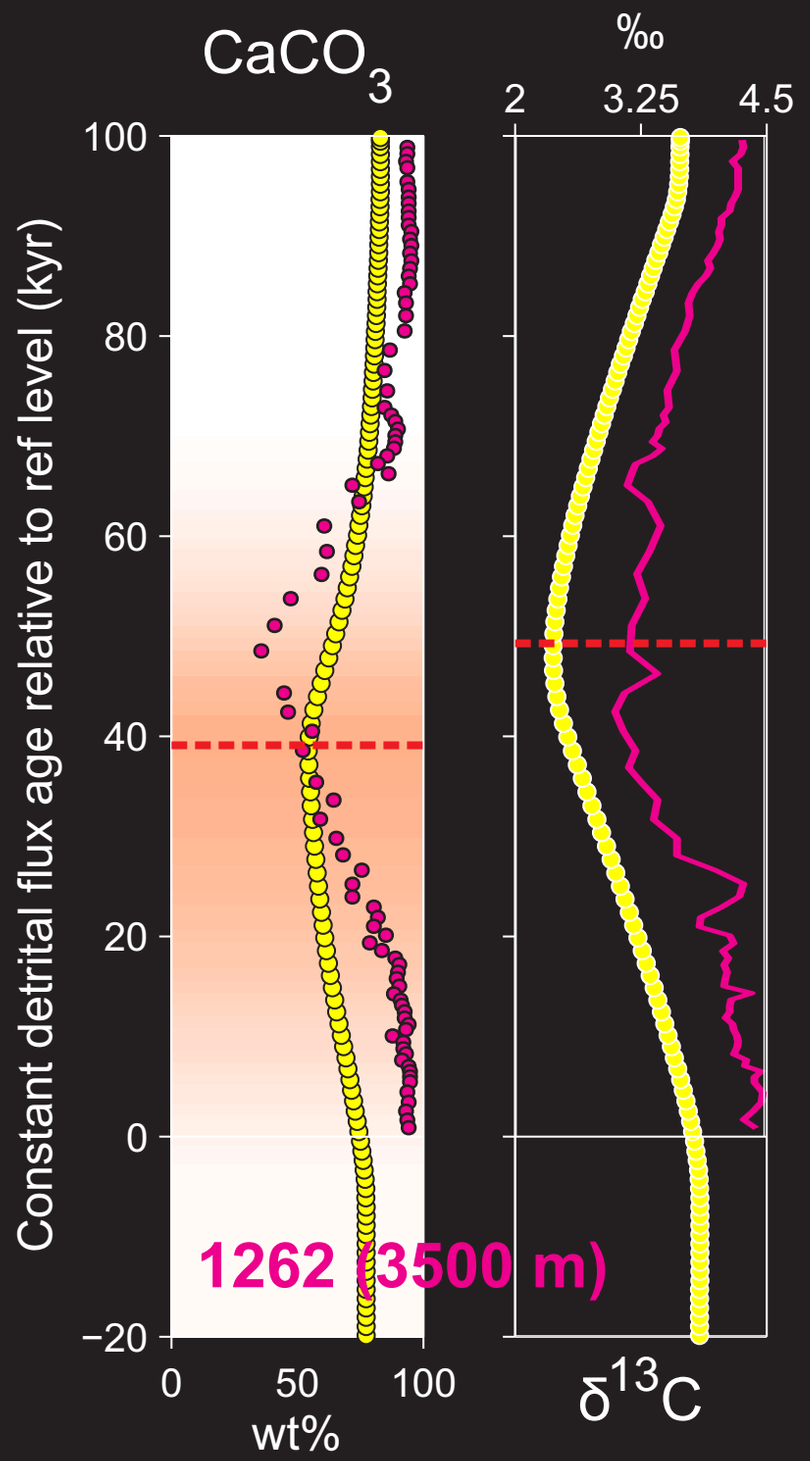
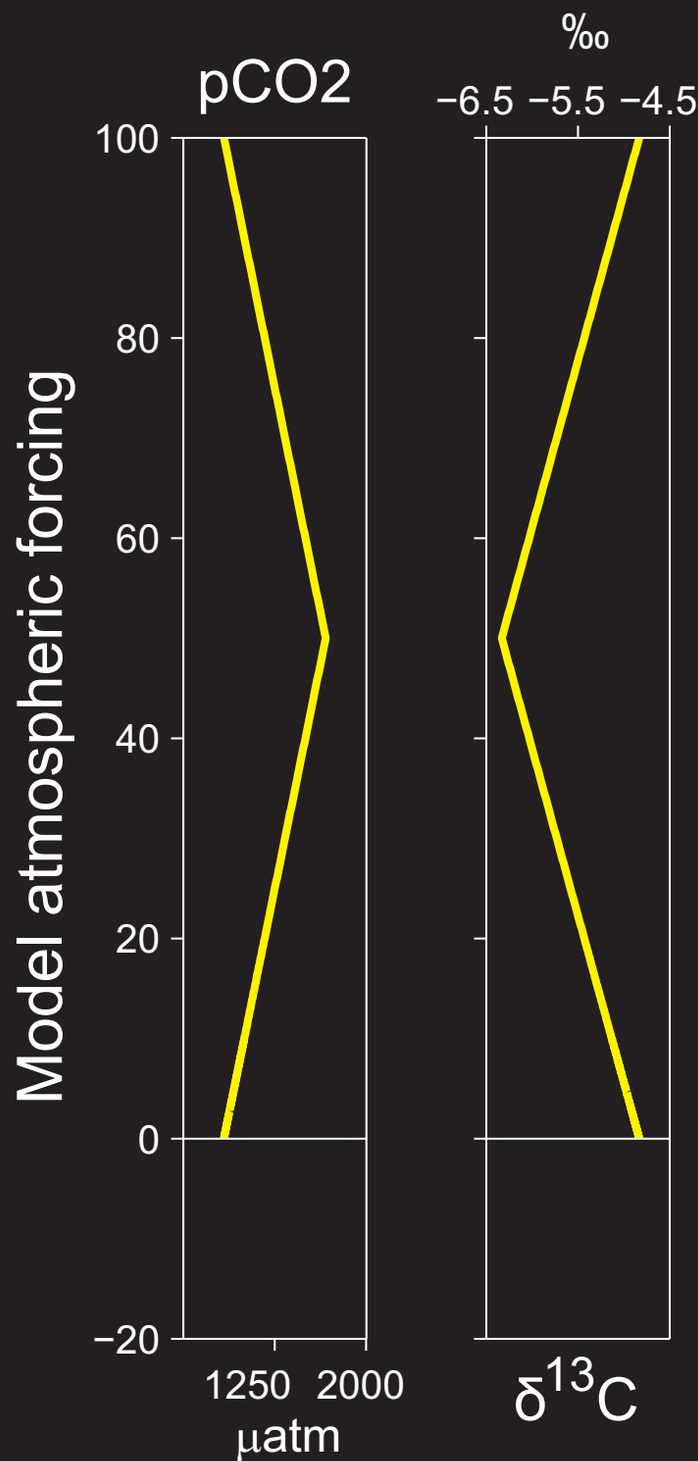
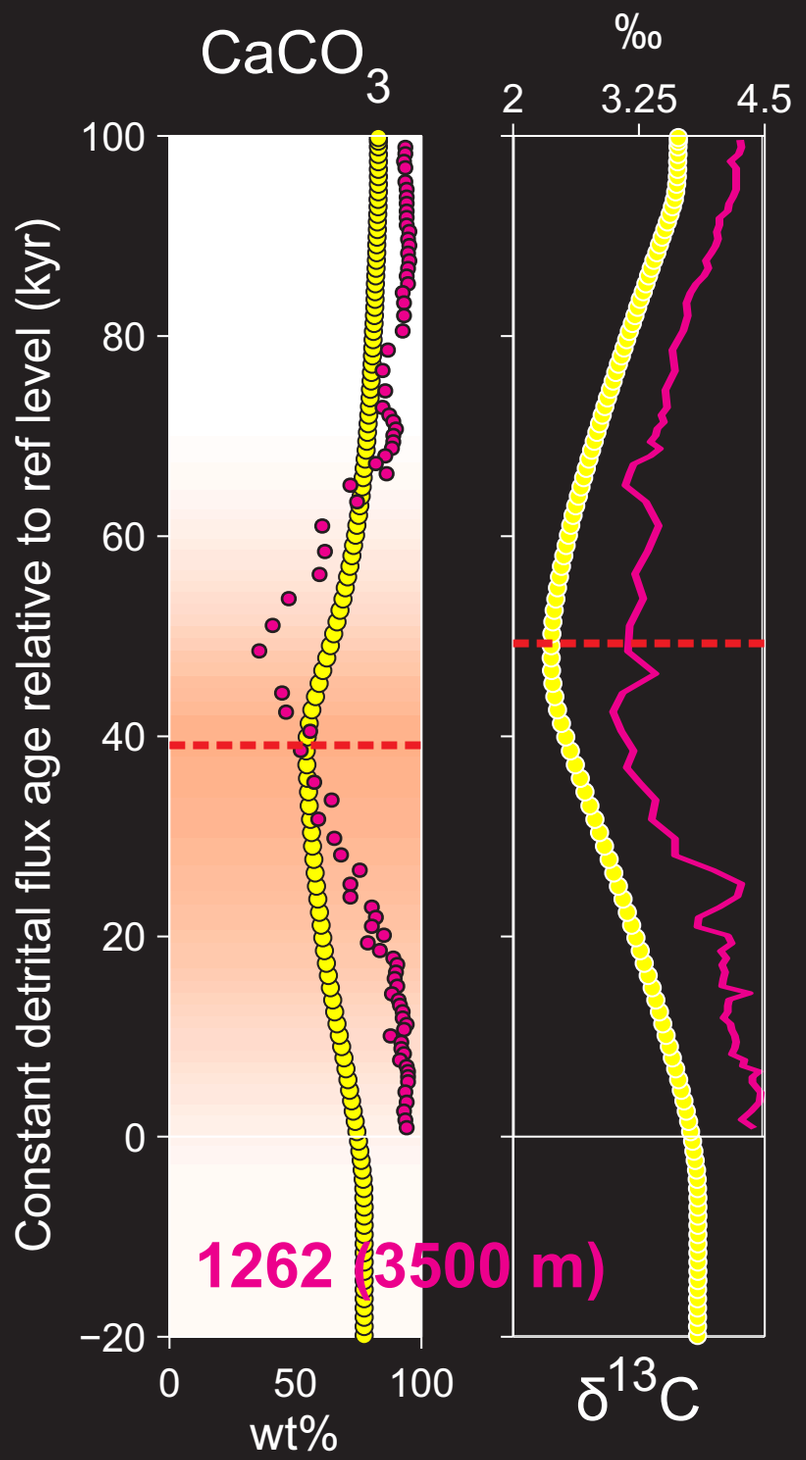
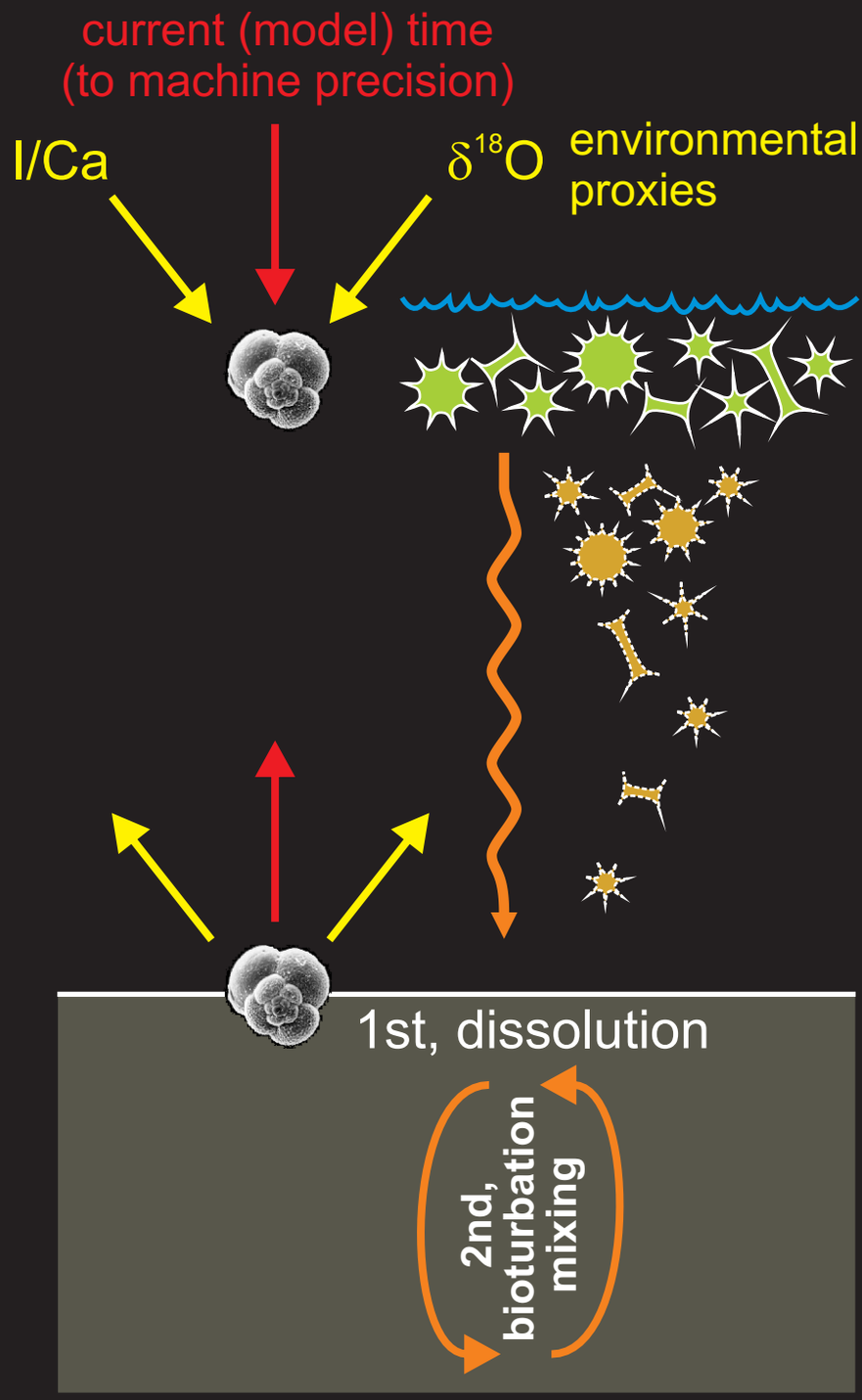


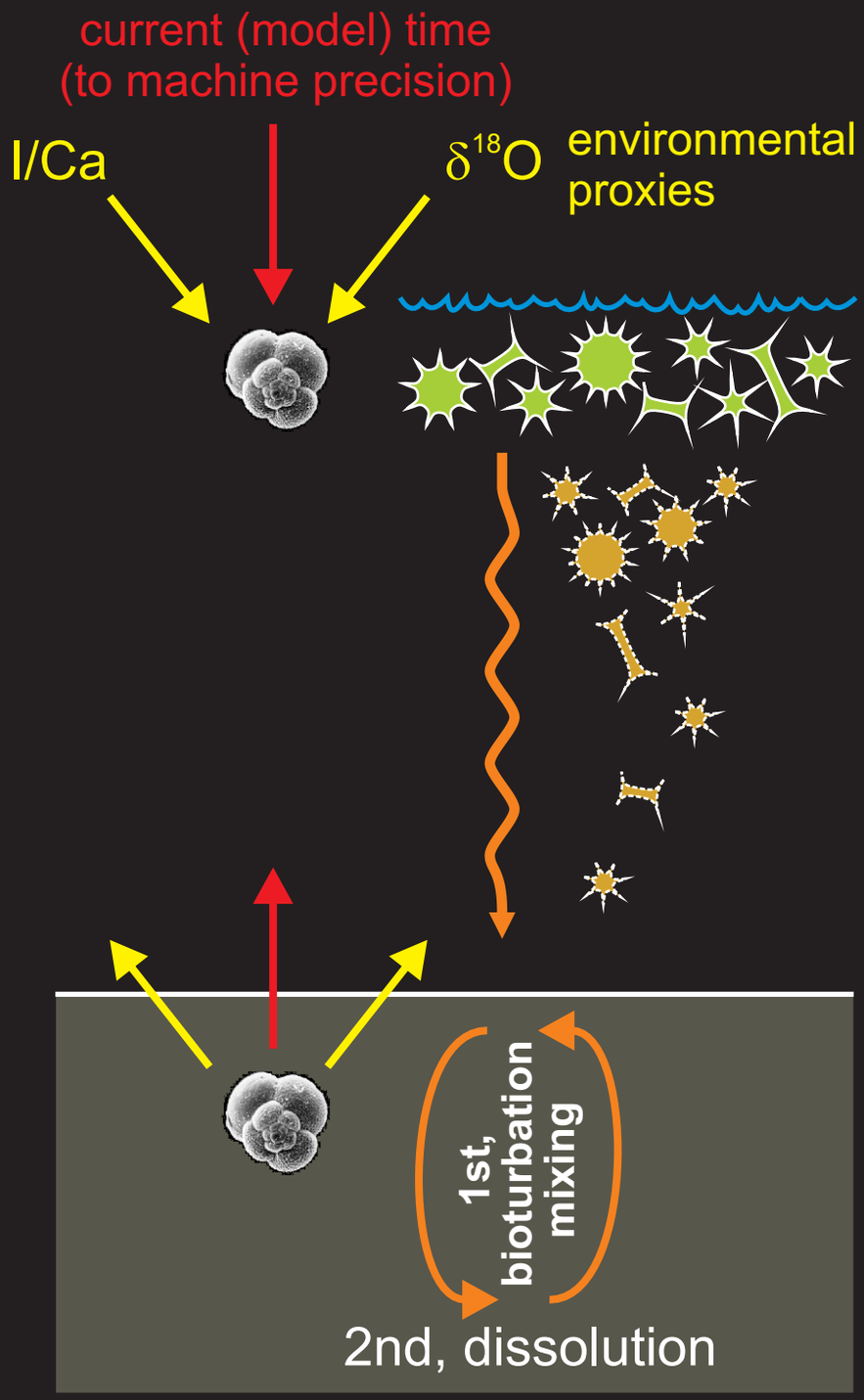


'Interface' $CaCO_3$ dissolution





'Homogeneous' $CaCO_3$ dissolution



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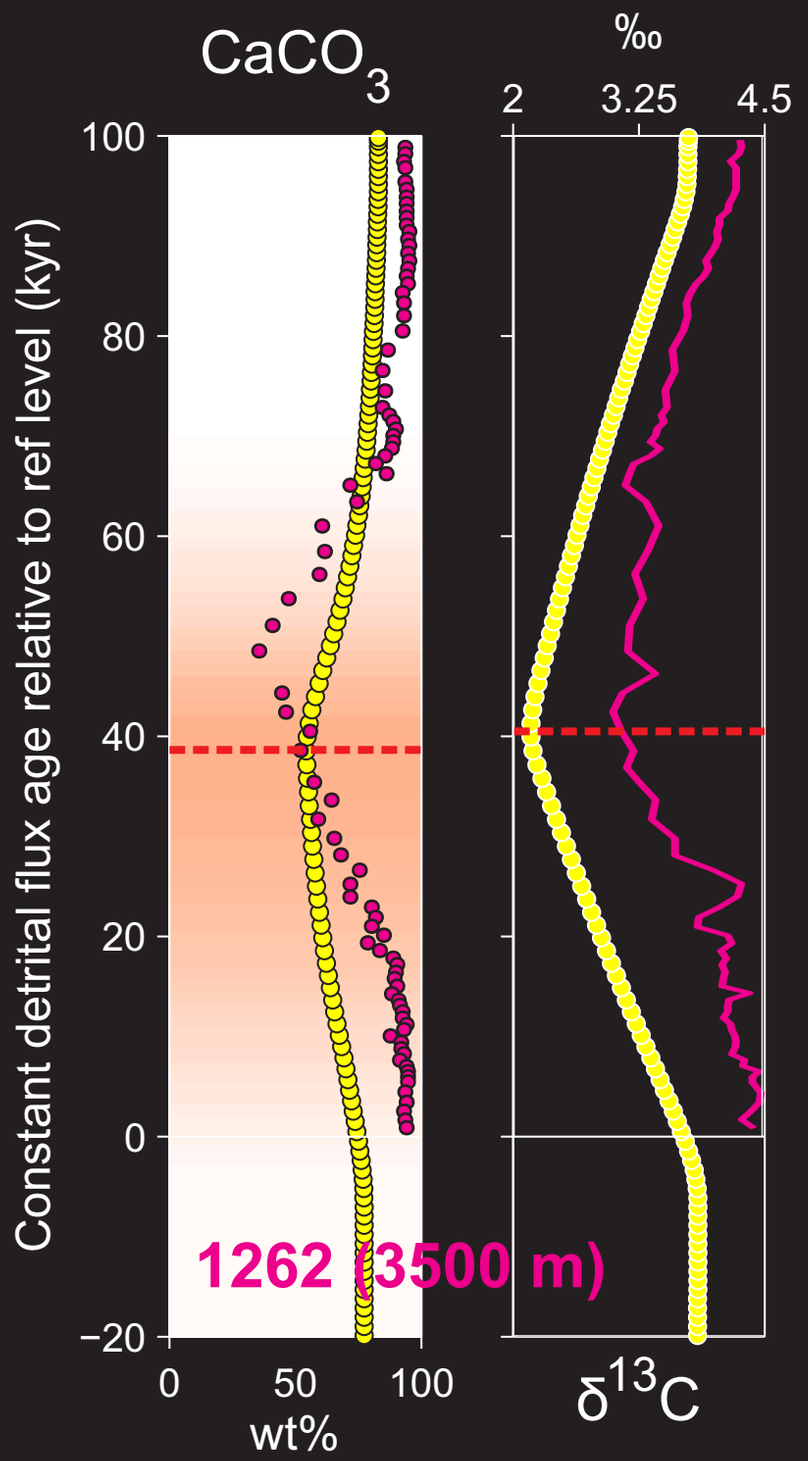
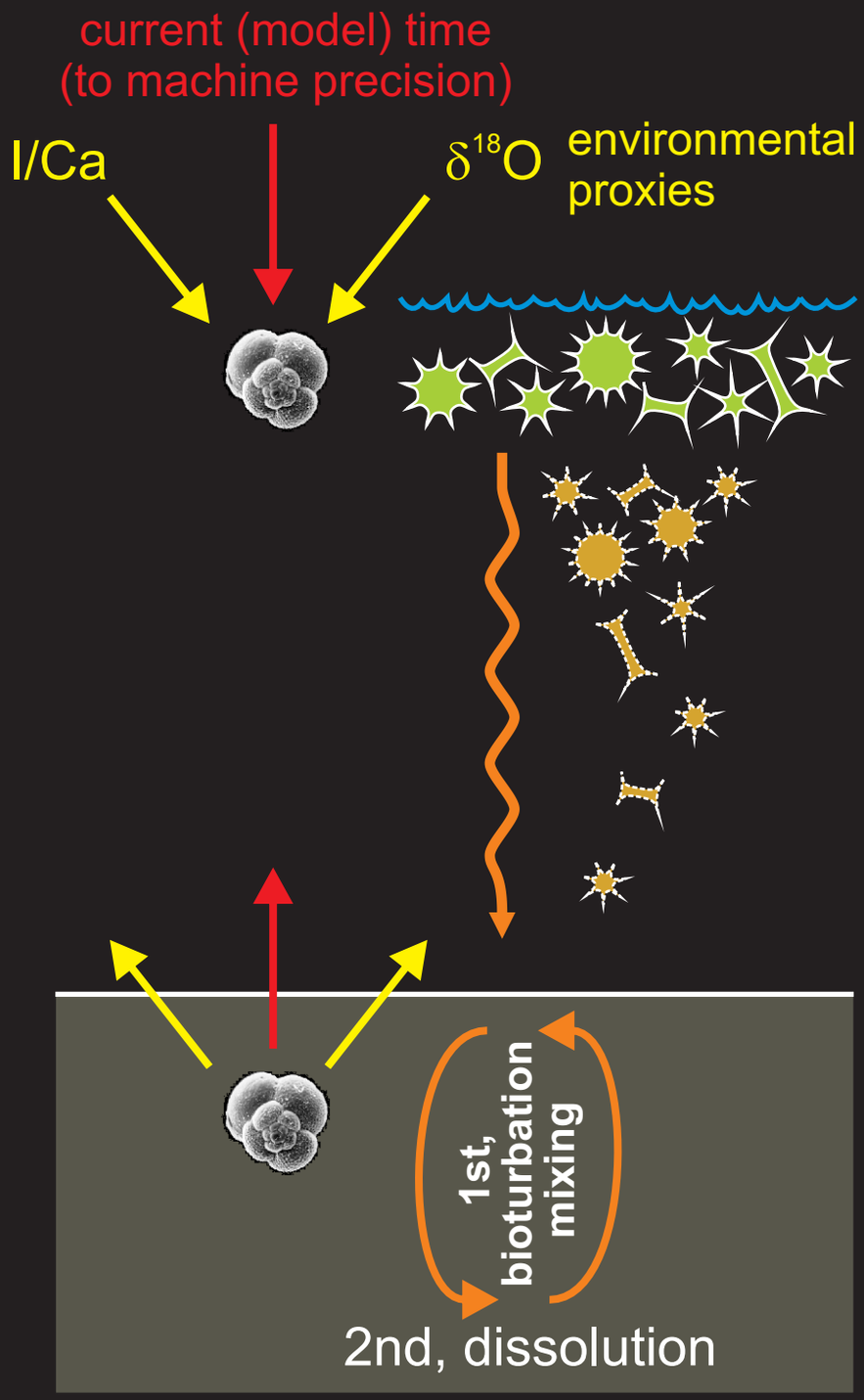
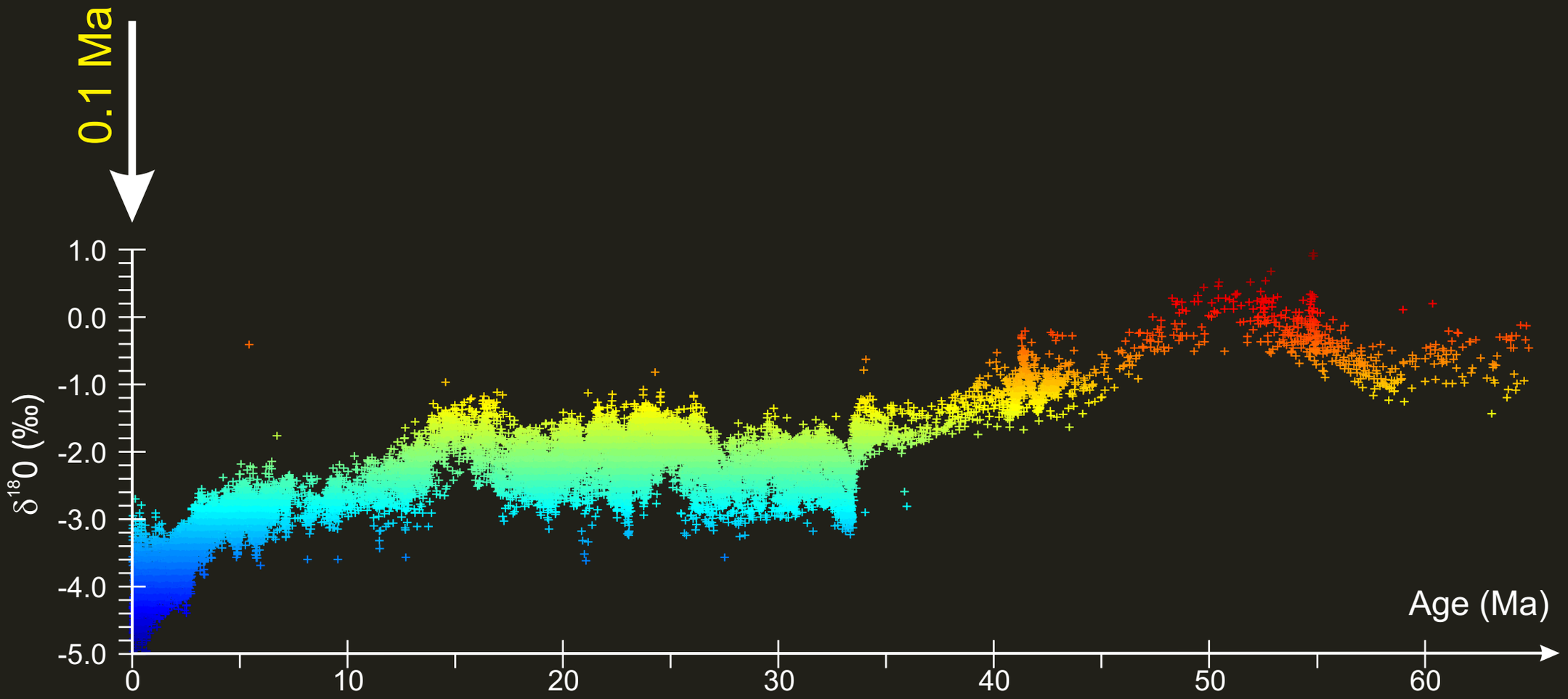


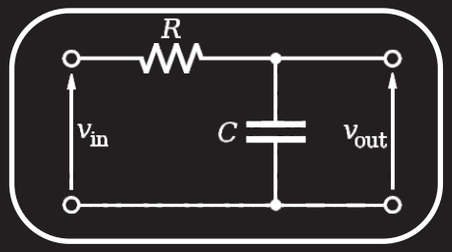


Shallow time, time (i.e. time in shallow time)

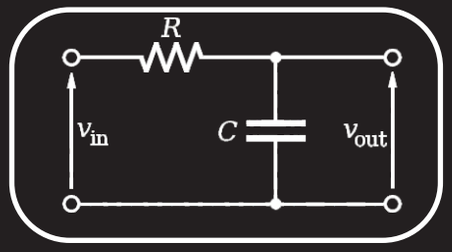


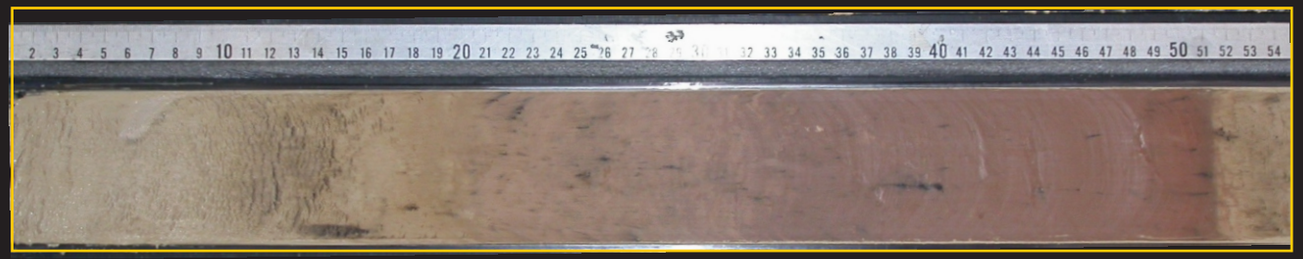
Shallow time, time (i.e. time in shallow time)

dissolution
(peservation)

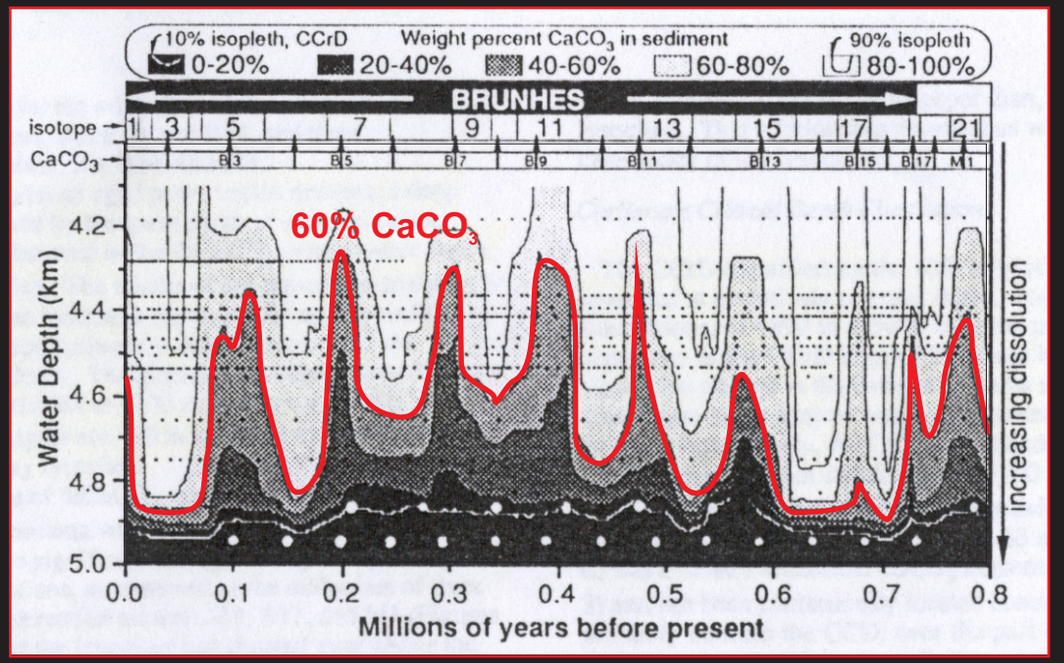


mixing
(bioturbation)





Farrell and Prell [1989]

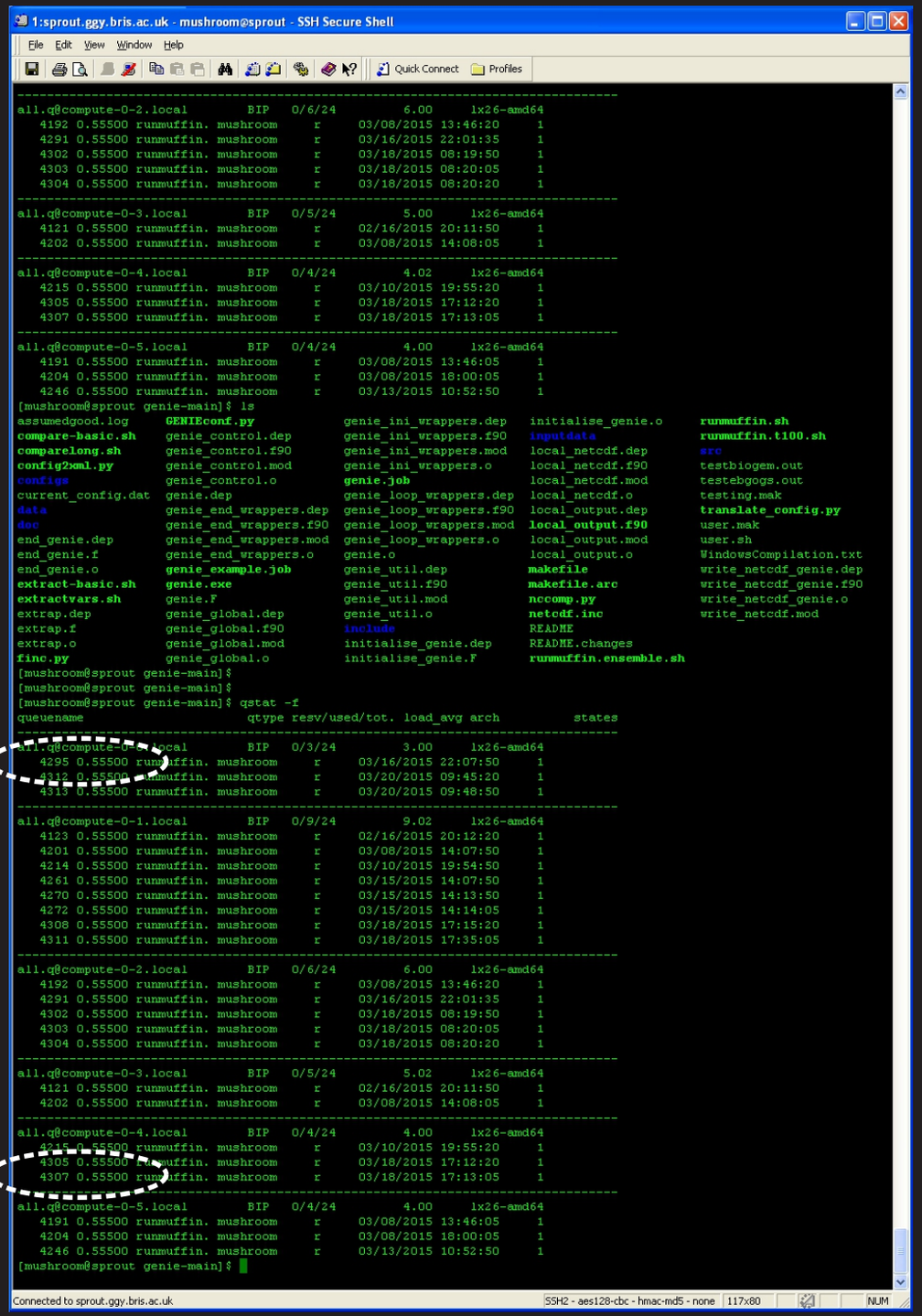


Shallow time, time (i.e. time in shallow time)

Consider: Co-varying (glacial-interglacial) $CaCO_3$ dissolution cycles and how a (varying) stable isotope is recorded

Methodology: $\delta^{18}O$ of planktic carbonate follows the LR04 stack, plus atmospheric pCO_2 is forced to follow the EPICA Dome C record, providing a varying preservation forcing on $CaCO_3$ in marine sediments.

Shallow time, time (i.e. time in shallow time)



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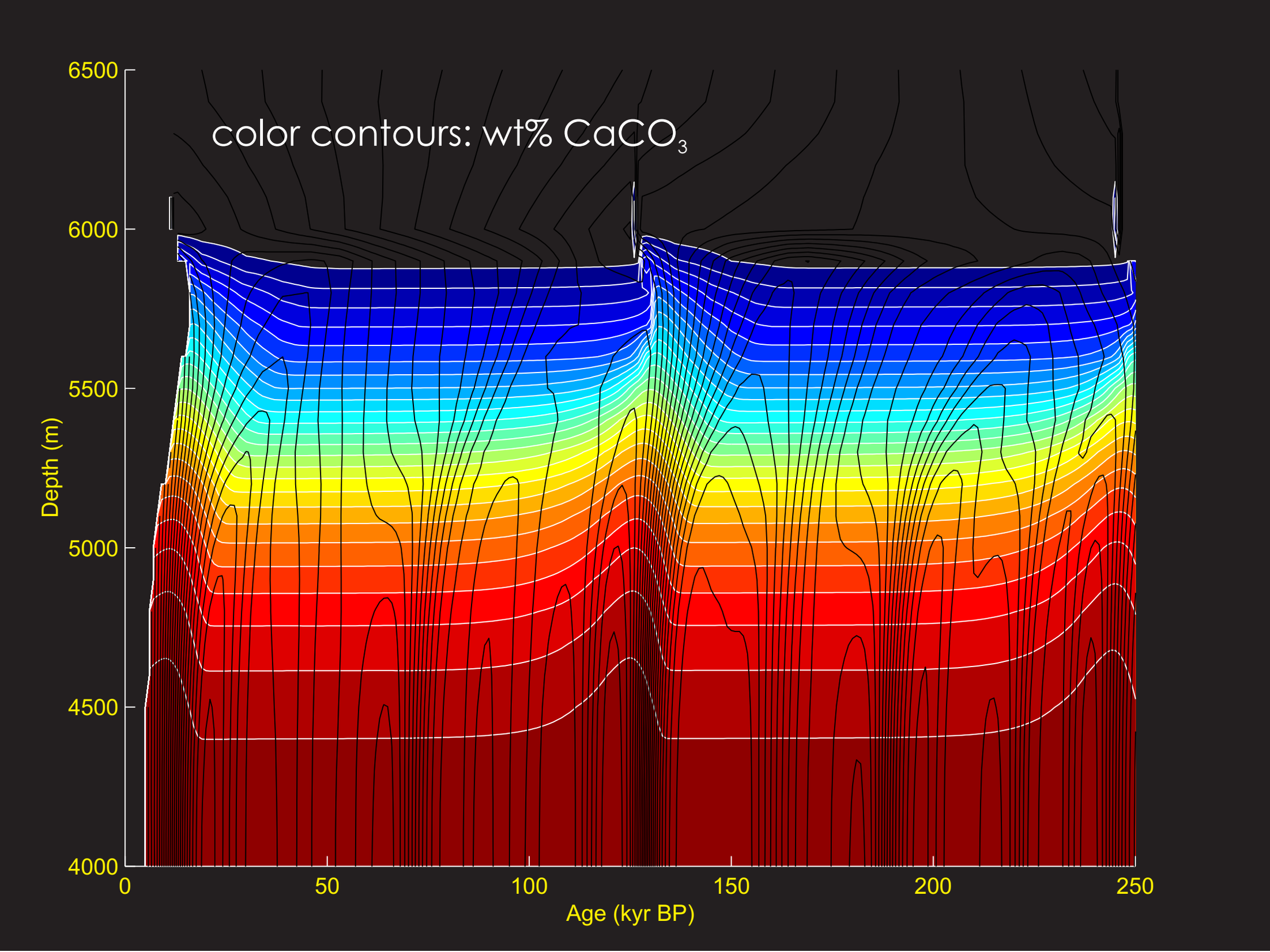
Instead: $\delta^{18}O$ of planktic carbonate follows SPECMAP while 500 PgC CO_2 removed from the atmosphere (to the terrestrial biosphere) across the deglacial transition (and then gradually added back again in a sawtooth shape).


color contours: wt% $CaCO_3$
6500
6000
5500
5000
4500
4000
Depth (m)
0
50
100
150
200
250
Age (kyr BP)

Age (kyr BP)
0
50
100
150
200
250
4000
4200
4400
4600
4800
Depth (m)
color contours: wt% CaCO3

Age (kyr BP)
0
50
100
150
200
250
4000
4200
4400
4600
4800
Depth (m)
color contours: δ18O in bulk CaCO3

Implications

- Once again, it matters 'where' $CaCO_3$ dissolution occurs (and what carbonate fraction) in accumulating sediments. Distortion of time-varying signals is likely minimized if a 'homogeneous' mode of dissolution dominates.
- Use of multiple benthic individuals (even if single species) will avoid bulk sediment artifacts (other proxies will be differentially affected though), but give rise to an entertaining convolution of benthic foram population dynamics (driven by $[O_2]$ and Corg flux variability), with a time-varying G-I environmental signal. (This would be an 'interface' like situation.)
- Single foram analyses in which both age-scale and environmental proxy are simultaneously measured, is ideal. But e.g. $\delta^{18}O$ would be adequate (^{14}C not essential).
- Modellers should learn some marine geology.

Outcome

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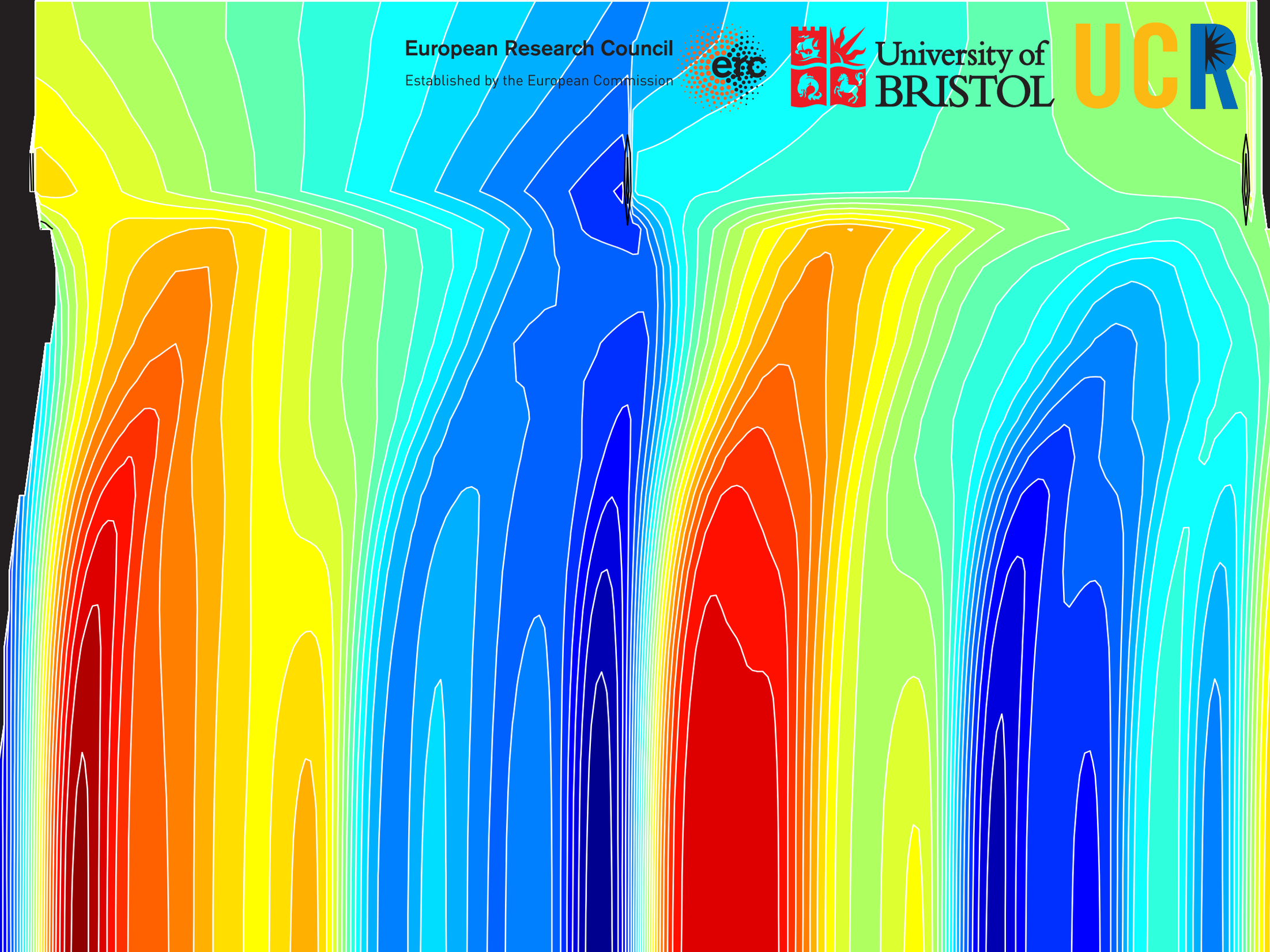
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University of
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Answers to questions