Dates, Rates and Global Correlation of the Permian of West Texas Based on Coupled U-Pb Carbonate Ages and Sr Chemostratigraphy*

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Abstract

The Permian Basin of Texas has a marine record that extends through the Late Permian. Thus changes in sea level that, in part, reflect changes in southern ice sheets of Gondwana are recorded within these Permian low-latitude strata. A U-Pb-carbonate-age-constrained 87Sr/86Sr trend shows a rapid decline from a Pennsylvanian high of 0.70825, to a Carboniferous-Permian boundary value of 0.70815, consistent with published Sr trends and U-Pb zircon ages from the type sections in the Urals. The decline in 87Sr/86Sr is coincident with multiple lines of evidence for increasing aridity in the Pangean tropics and results from a decrease in continental contributions to the global marine Sr reservoir relative to other sources. This trend of declining Sr is consistent with reduced silicate weathering.

Permian Basin icehouse-style high-amplitude and high-frequency cycles (cyclothems) are replaced by greenhouse-style low-amplitude cycles at Wichita/Abo (Sakmarian) time. This change follows a 17 km step-back of the shelf deposits on the Central Basin Platform that is interpreted as a major transgression. This transgression occurred at an 87Sr/86Sr value of approximately 0.7078, no more than 6 million years after the onset of aridity. A model that links these observations is that reduced silicate weathering caused an increase in pCO_2, which has been recognized by terrestrial proxy records, and that the increase in this greenhouse gas was responsible for collapse of the long-lived Carboniferous-Permian glaciers. Transitional type cycles recognized in the Guadalupian may relate to a last pulse of Permian glaciation recognized in Australia.

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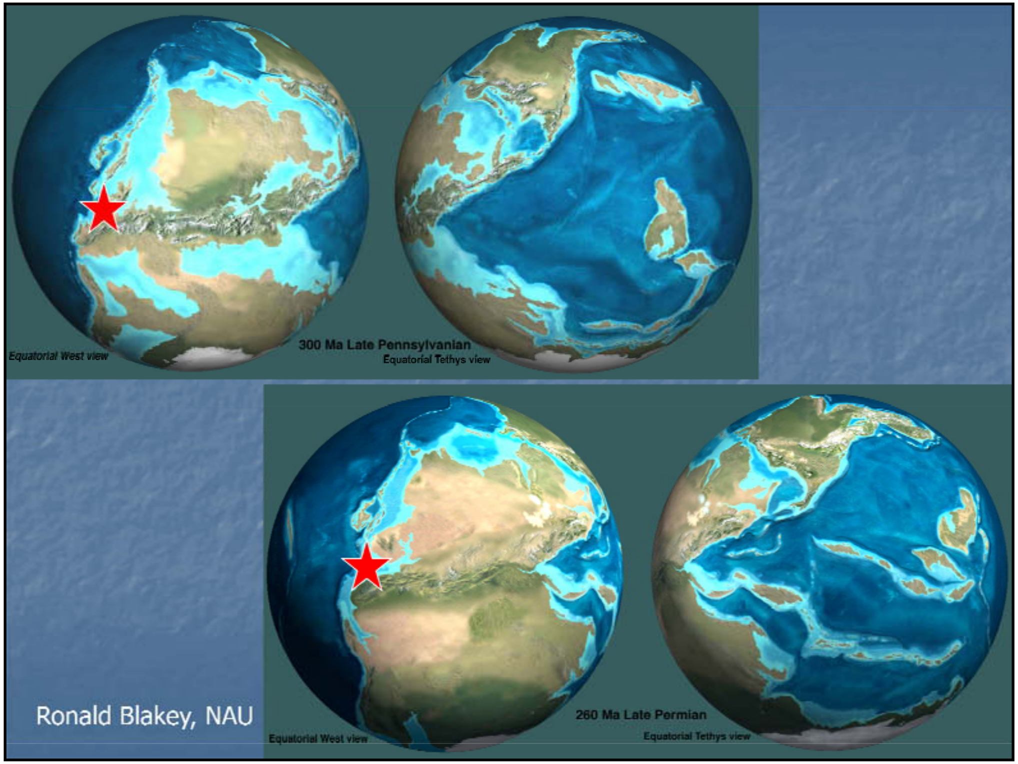
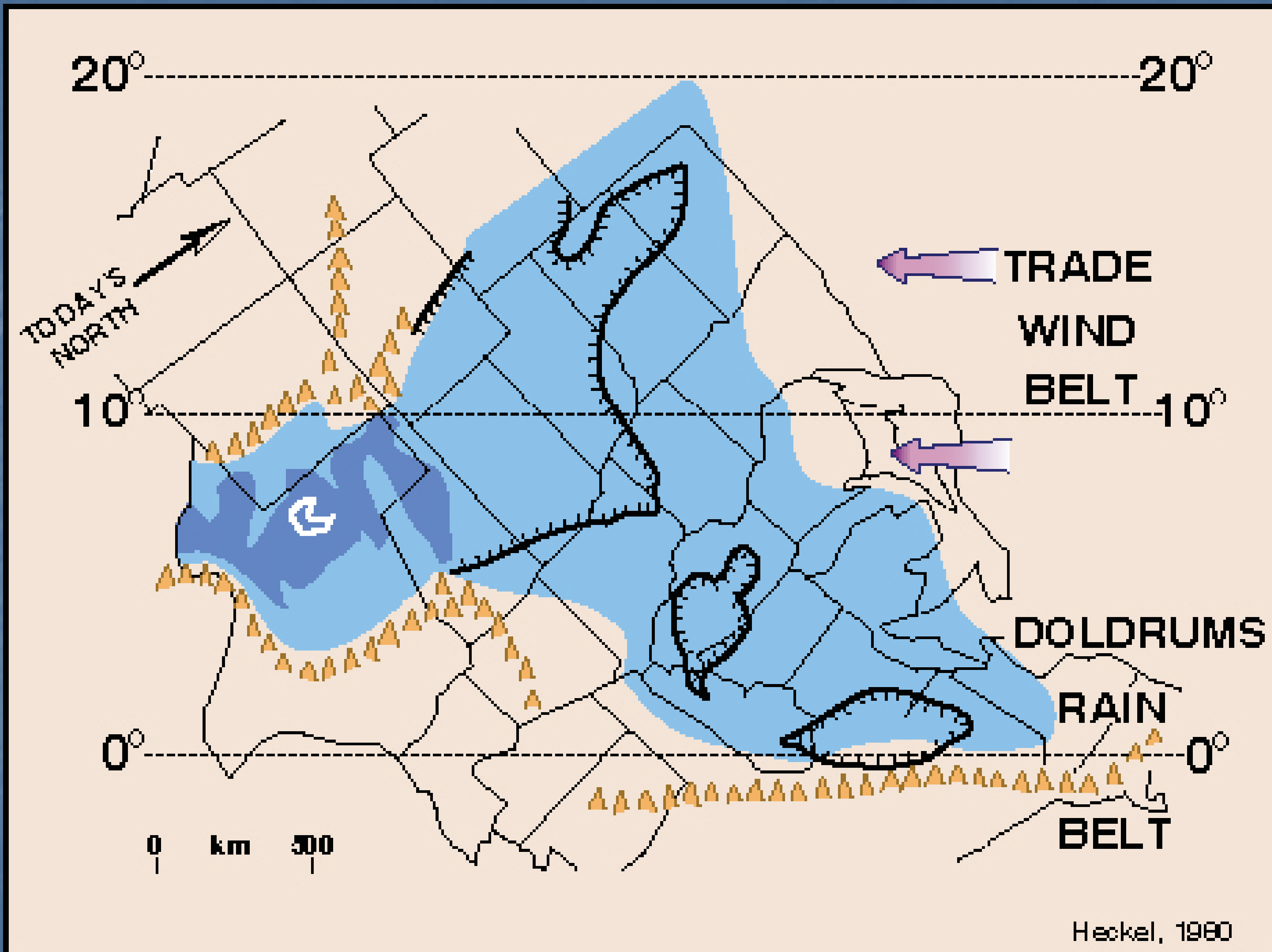
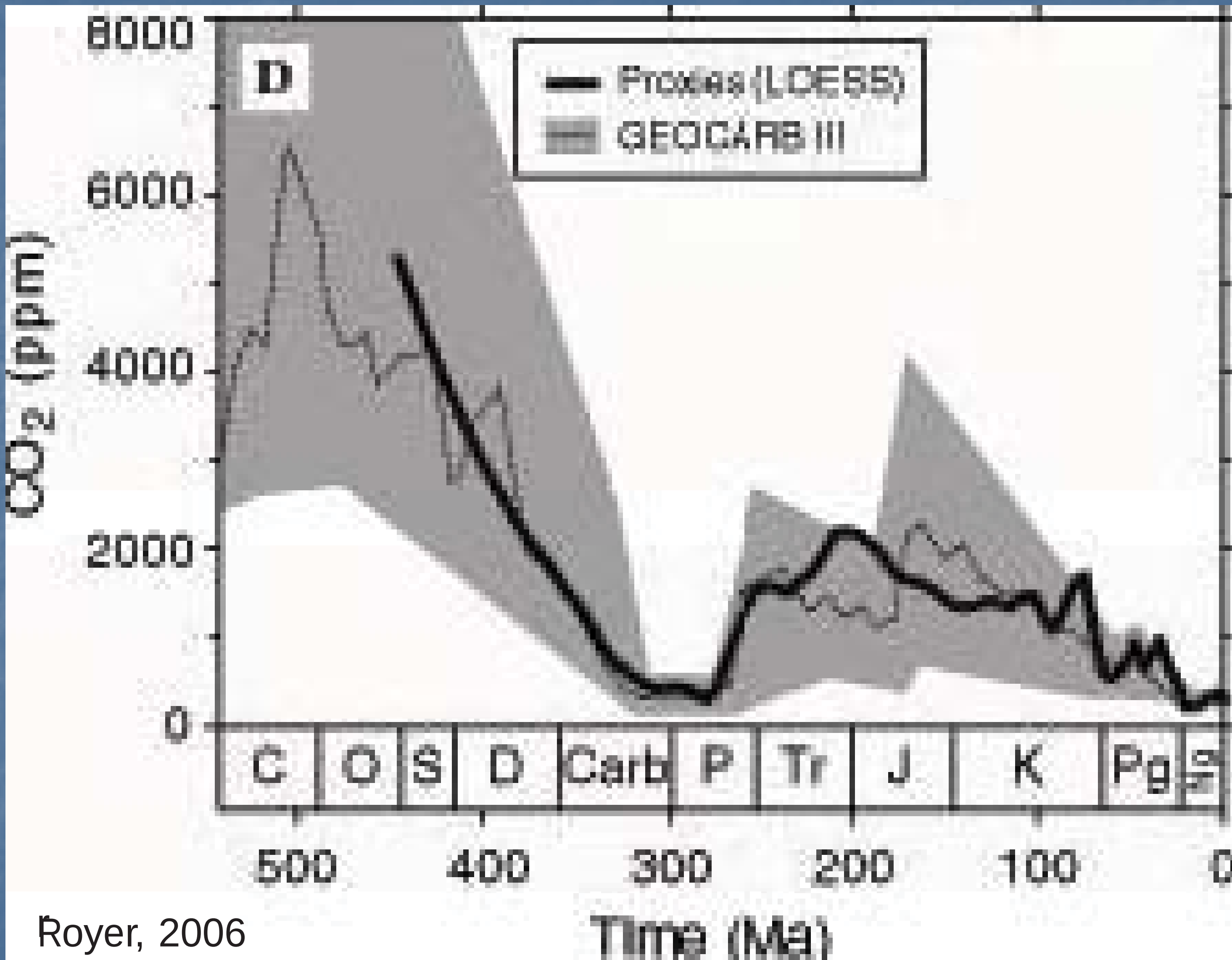
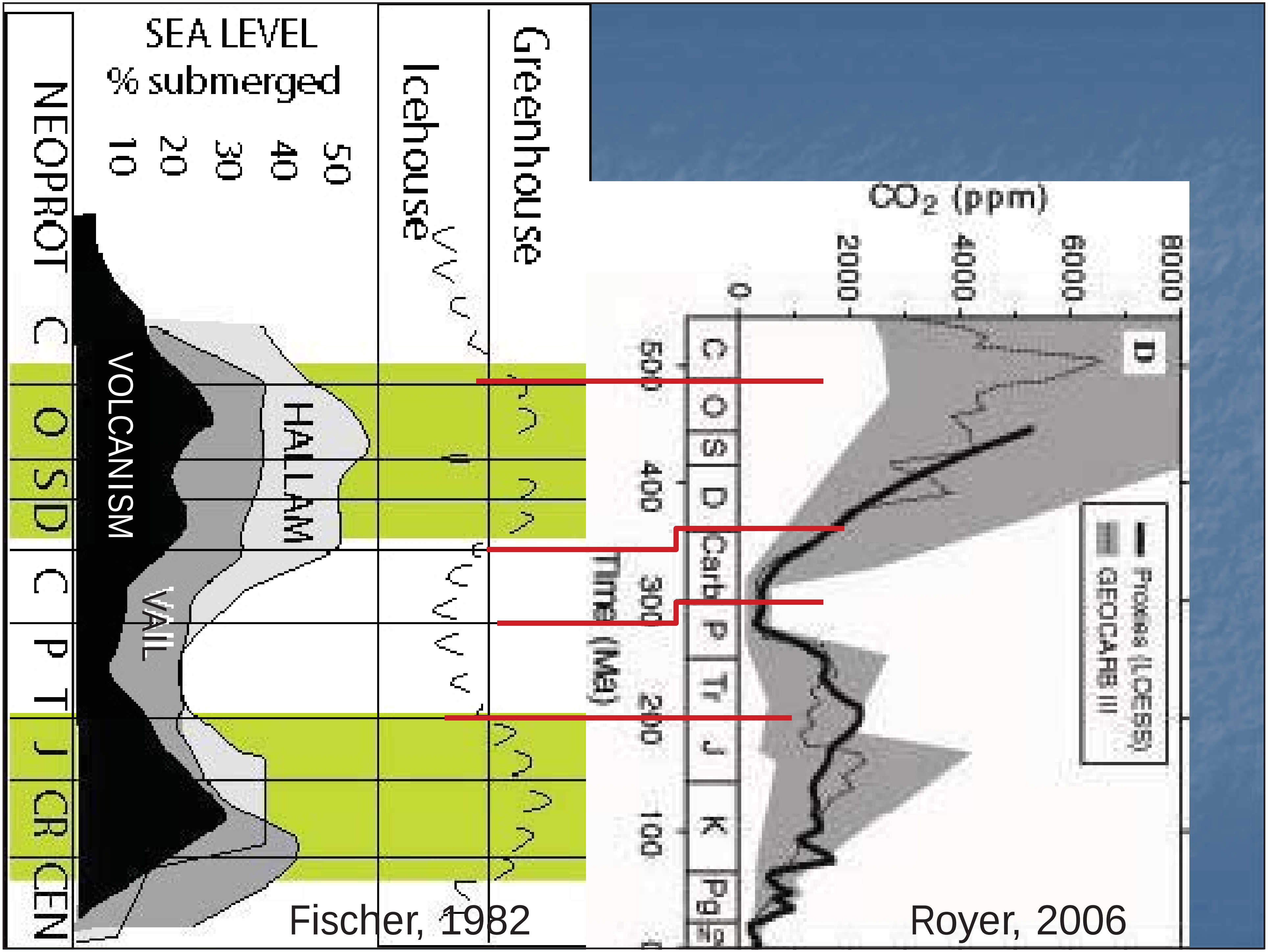


These are paleoreconstruction globes from Ronald Blakey at Northern Arizona Univ. The upper ones are for Late Pennsylvanian, right before the Carboniferous-Permian boundary. It shows glaciers in the southern hemisphere; the major mountain belt right at the equator is from the suturing of Africa (east) and South America (west) to North America during the assembly of the supercontinent Pangea. Note even though the continental masses are touching here, Blakey shows more water in the tropical latitudes than in the next diagram. Red star show the approximate area of our study.


20°
20°
TODAYS NORTH
TRADE
WIND
BELT
10°
10°
DOLDRUMS
RAIN
BELT
0°
0°
0 km 500
Heckel, 1980

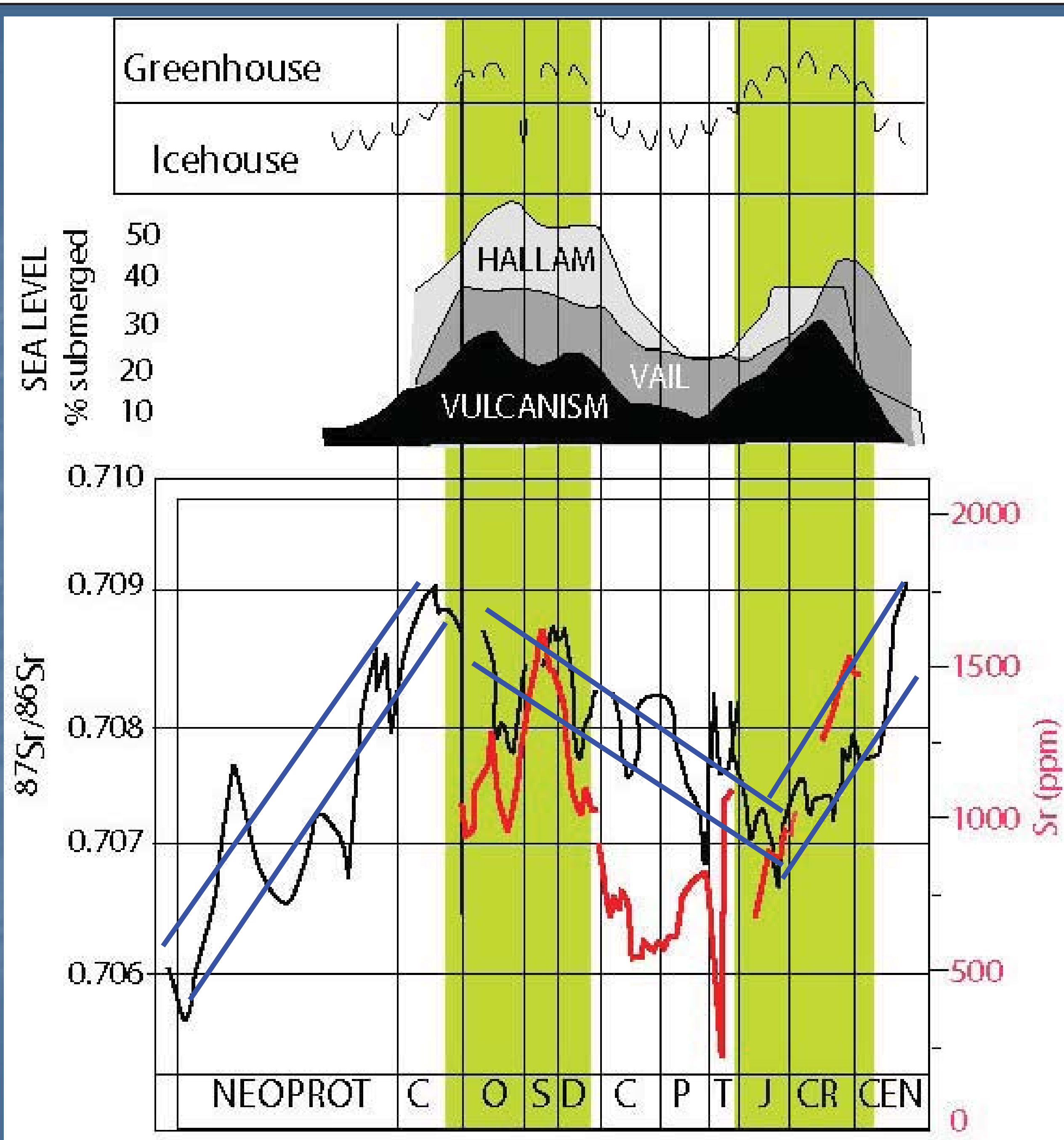

D
Proxies (LOESS)
GEOCARB III
8000
6000
4000
2000
0
CO2 (ppm)
C
O
S
D
Carb
P
Tr
J
K
Pg
500
400
300
200
100
0
Time (Ma)

Royer, 2006

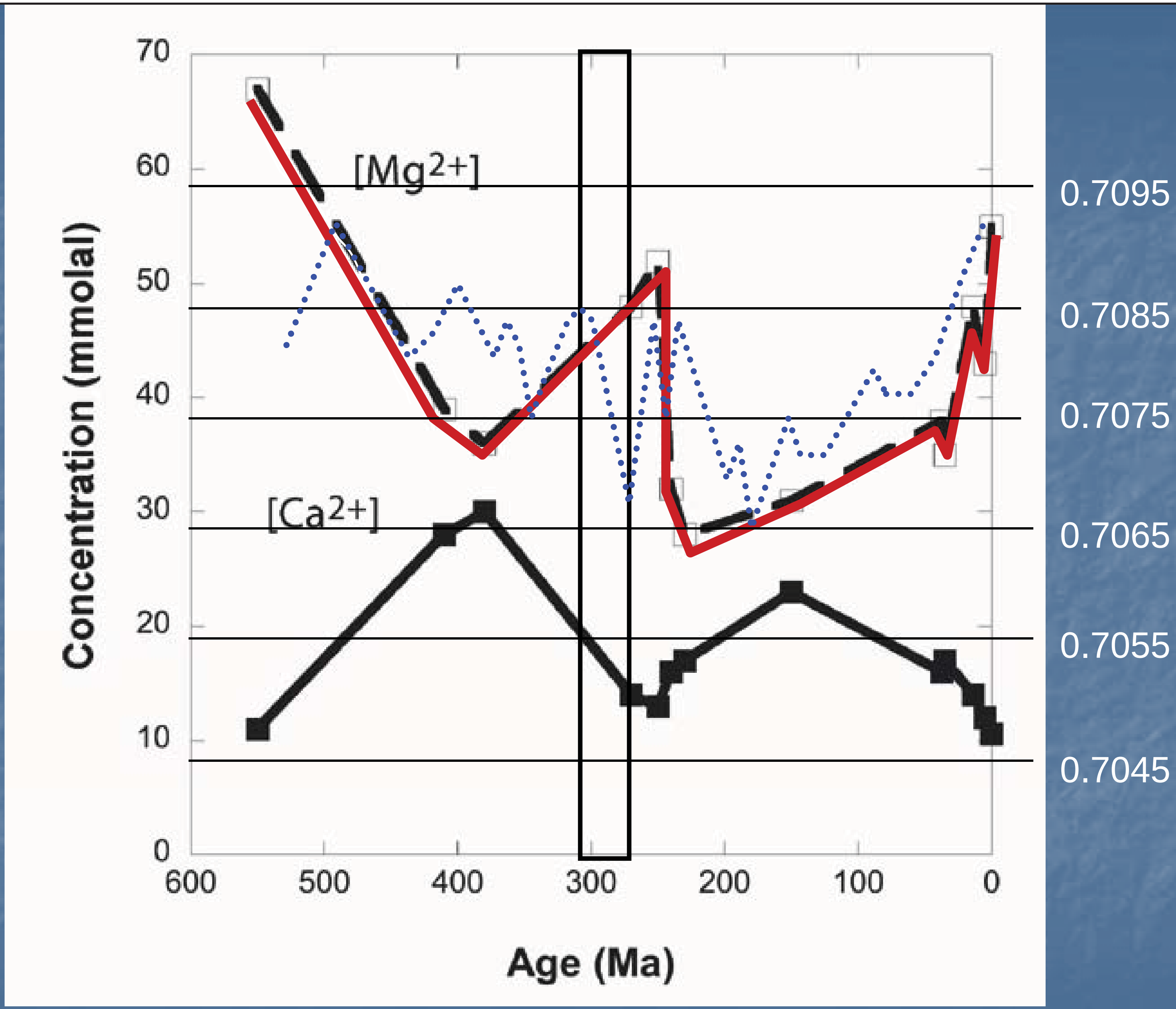


Fischer, 1982

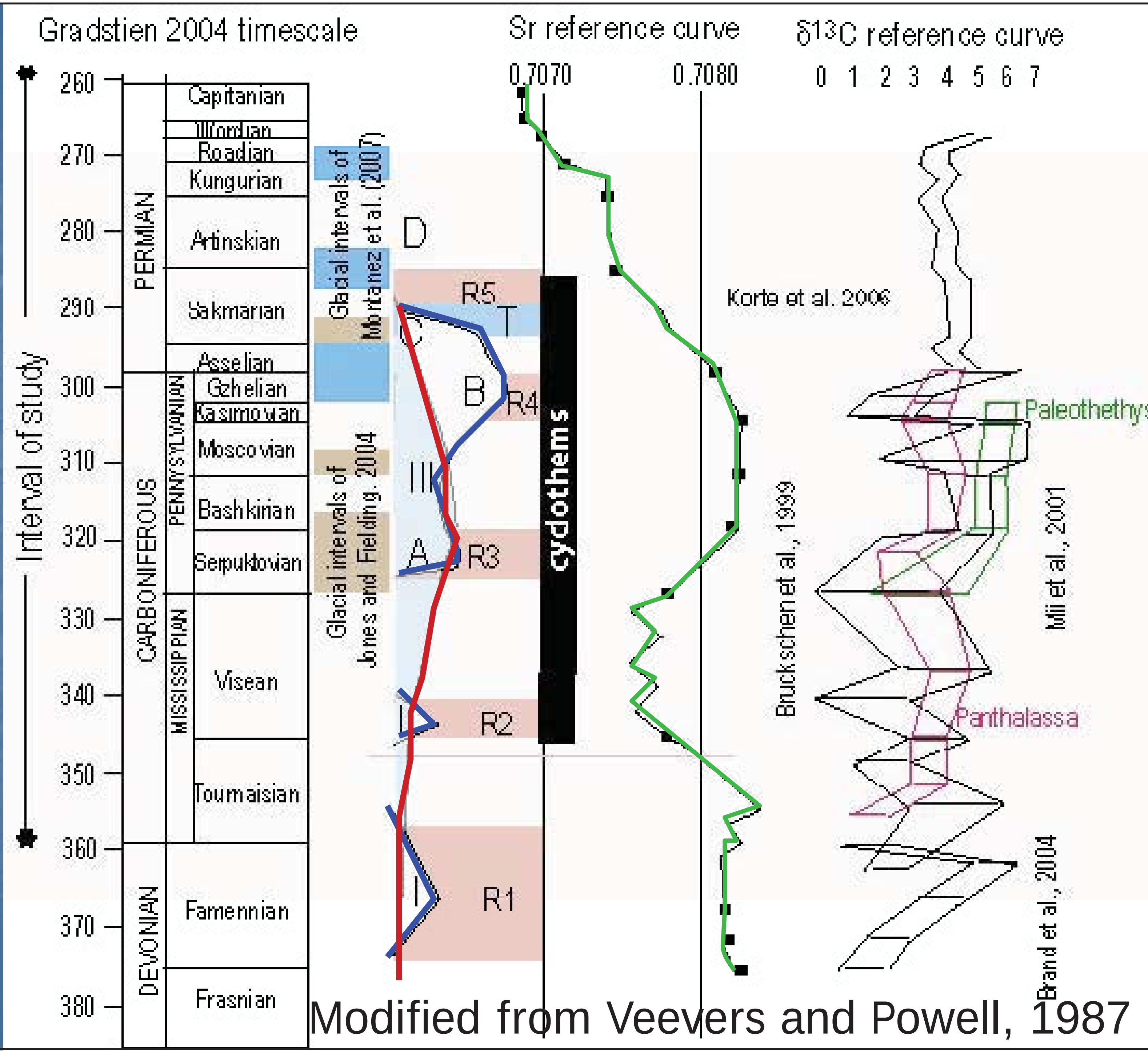
Royer, 2006



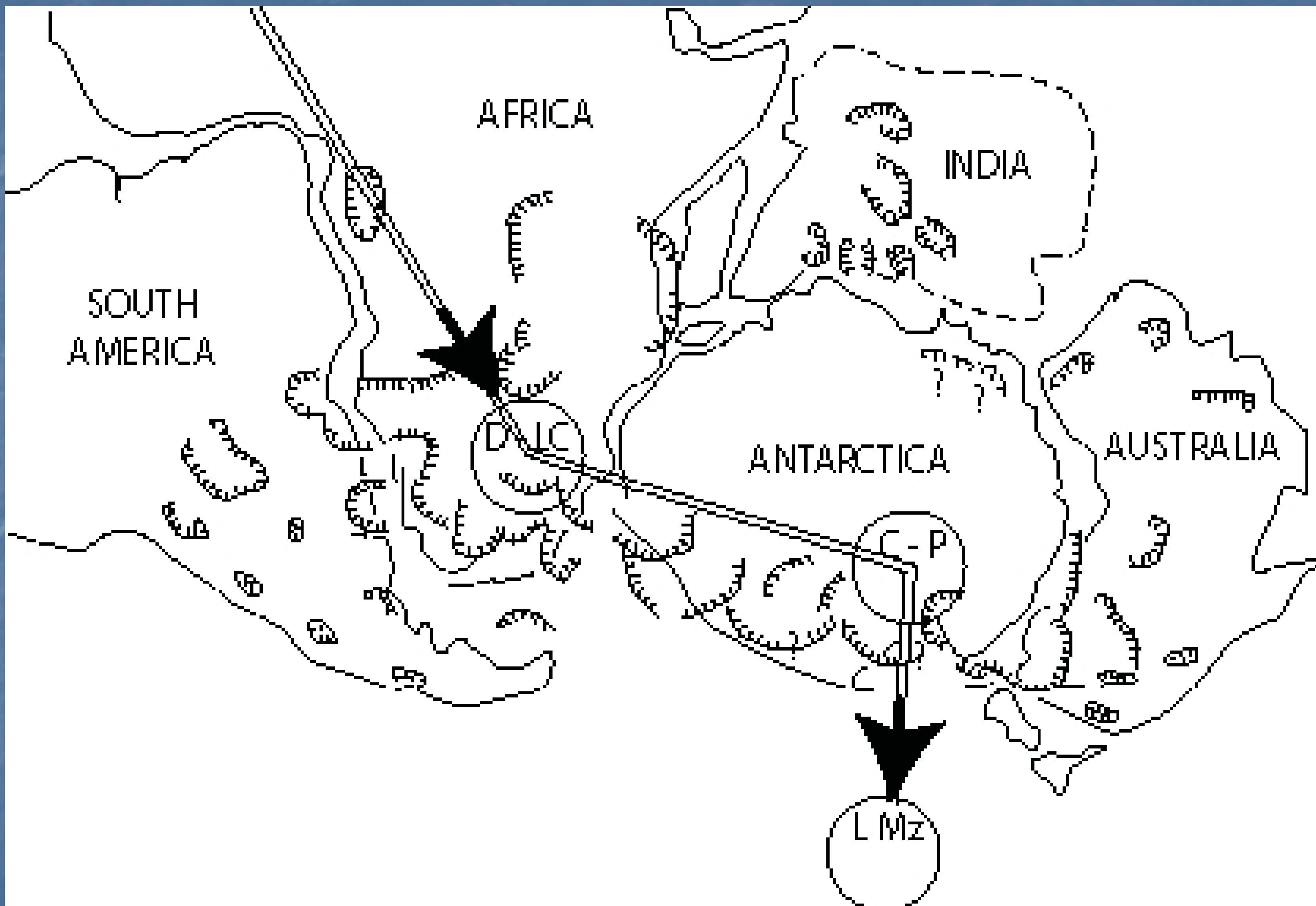
Jacobson et al.,1999,Veizer et al., 1999; Steuber and Veizer, 2002


70
60
50
40
30
20
10
0
Concentration (mmolal)
[Mg2+]
[Ca2+]
600
500
400
300
200
100
0
Age (Ma)
0.7095
0.7085
0.7075
0.7065
0.7055
0.7045

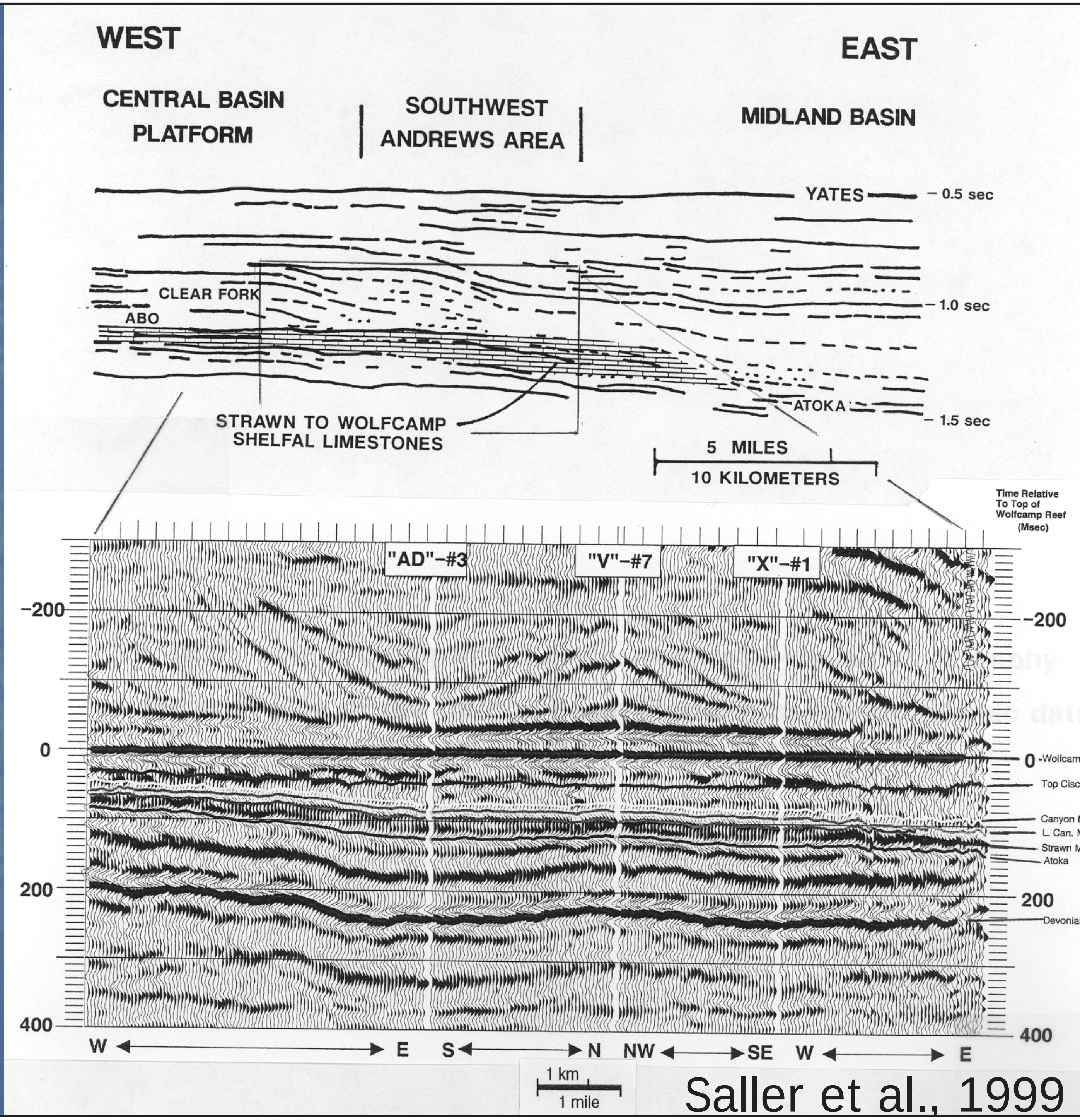
Kump, 2008



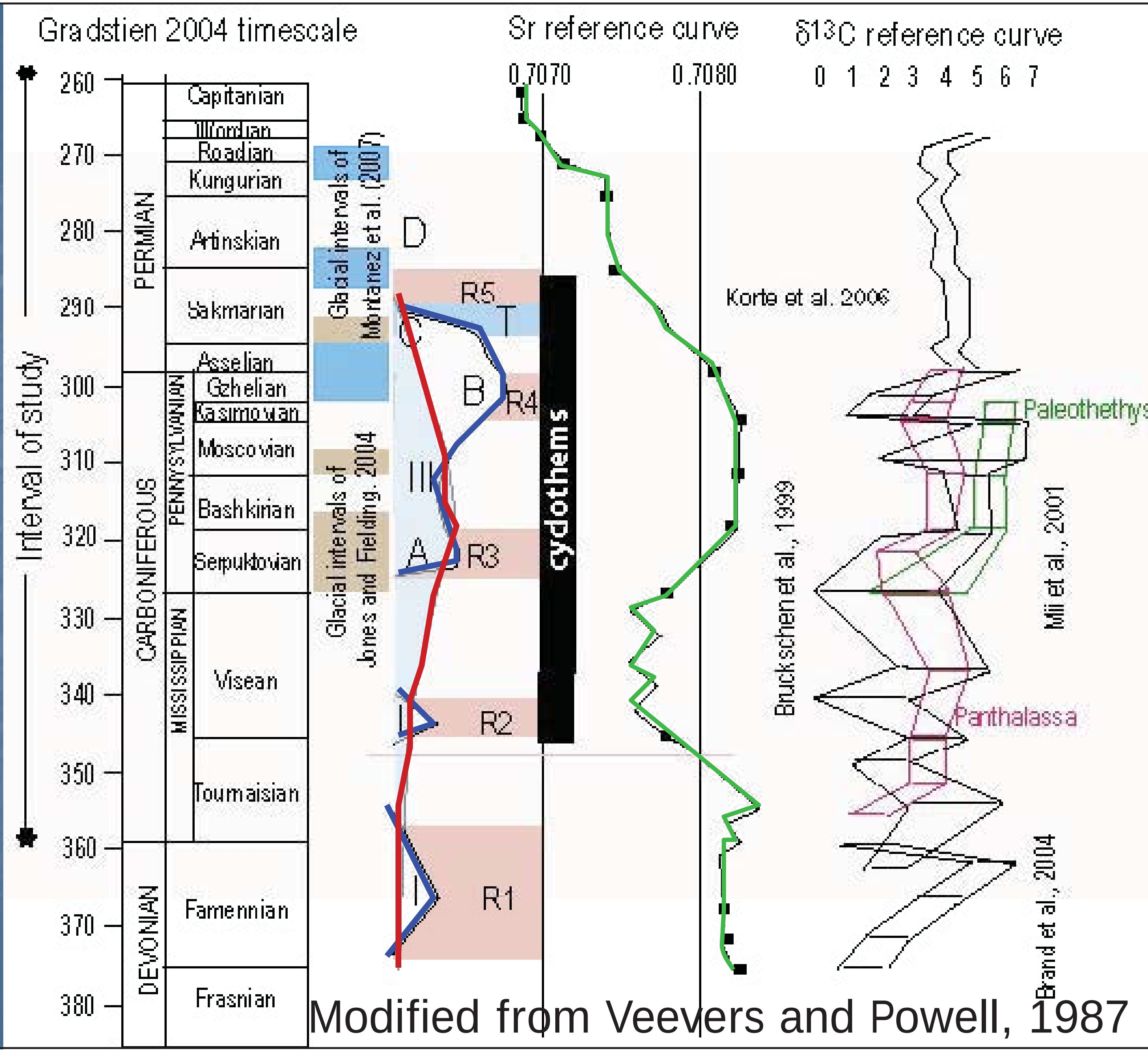
Modified from Veevers and Powell, 1987



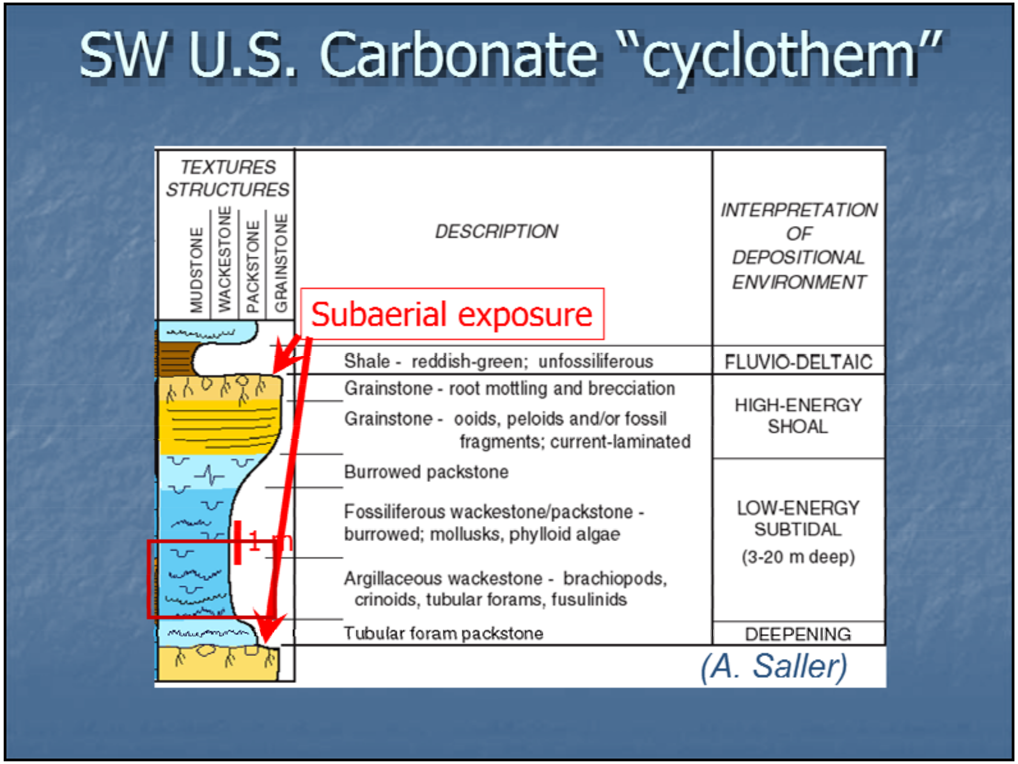
Crowell, 1978



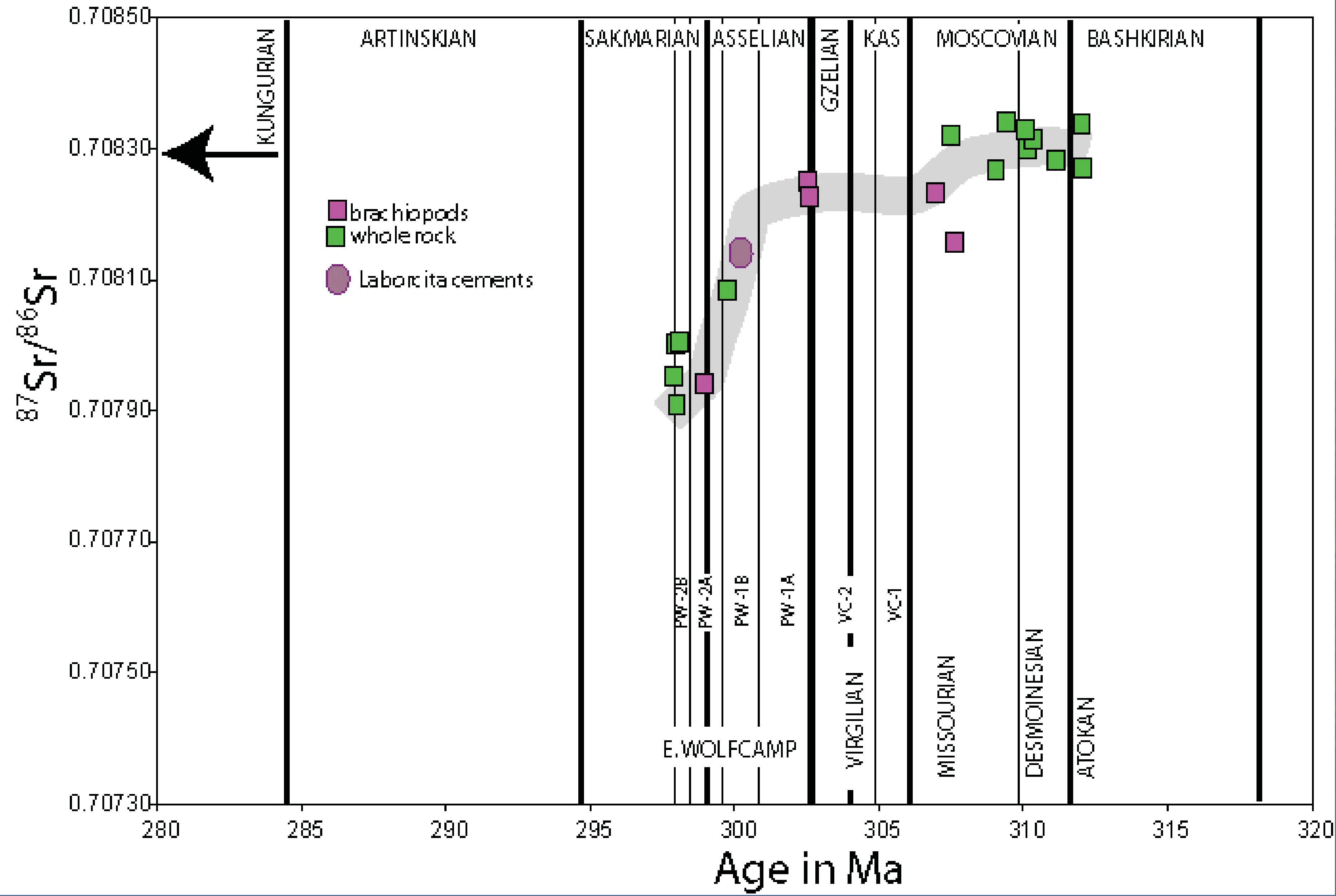
Saller et al., 1999



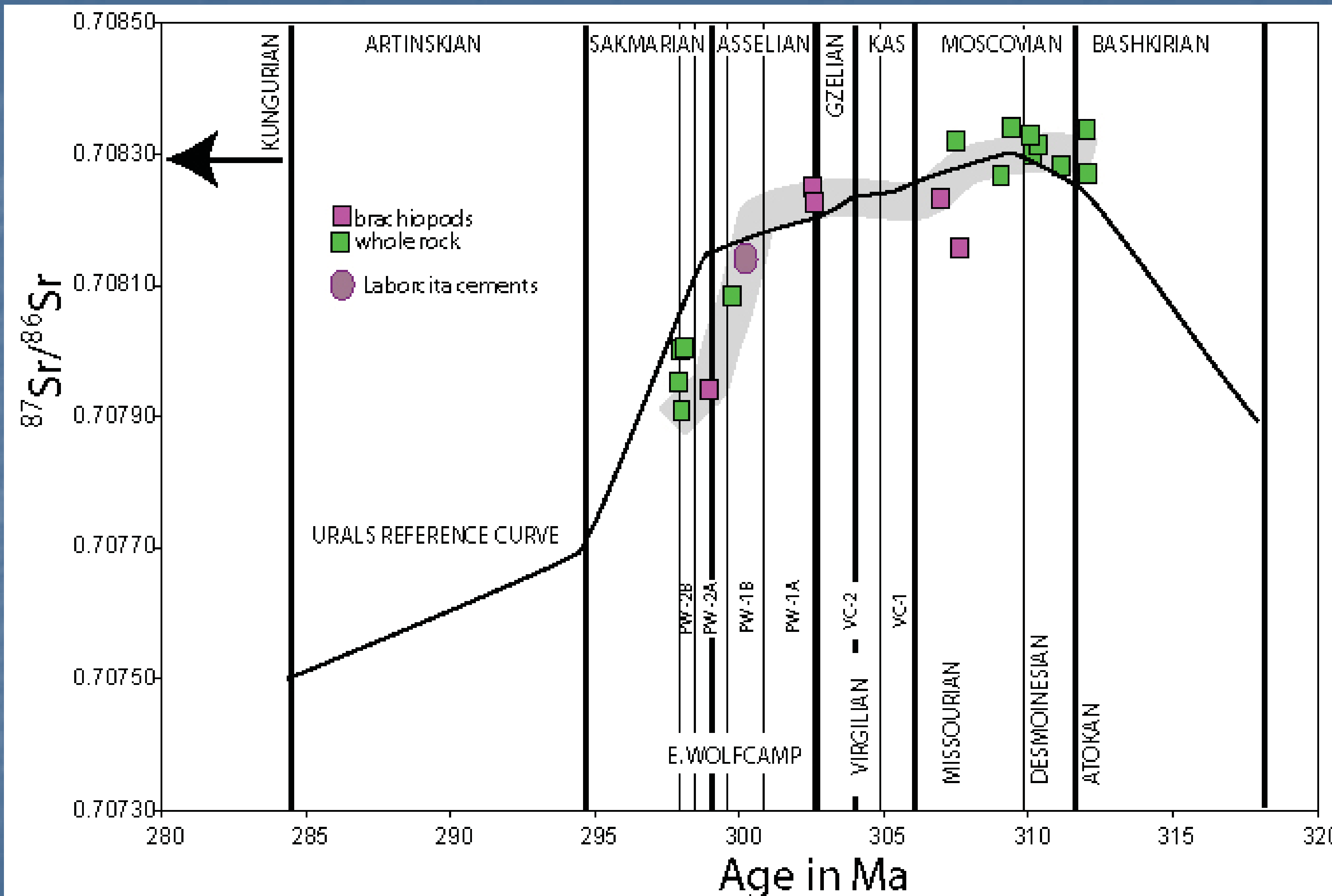
Modified from Veevers and Powell, 1987



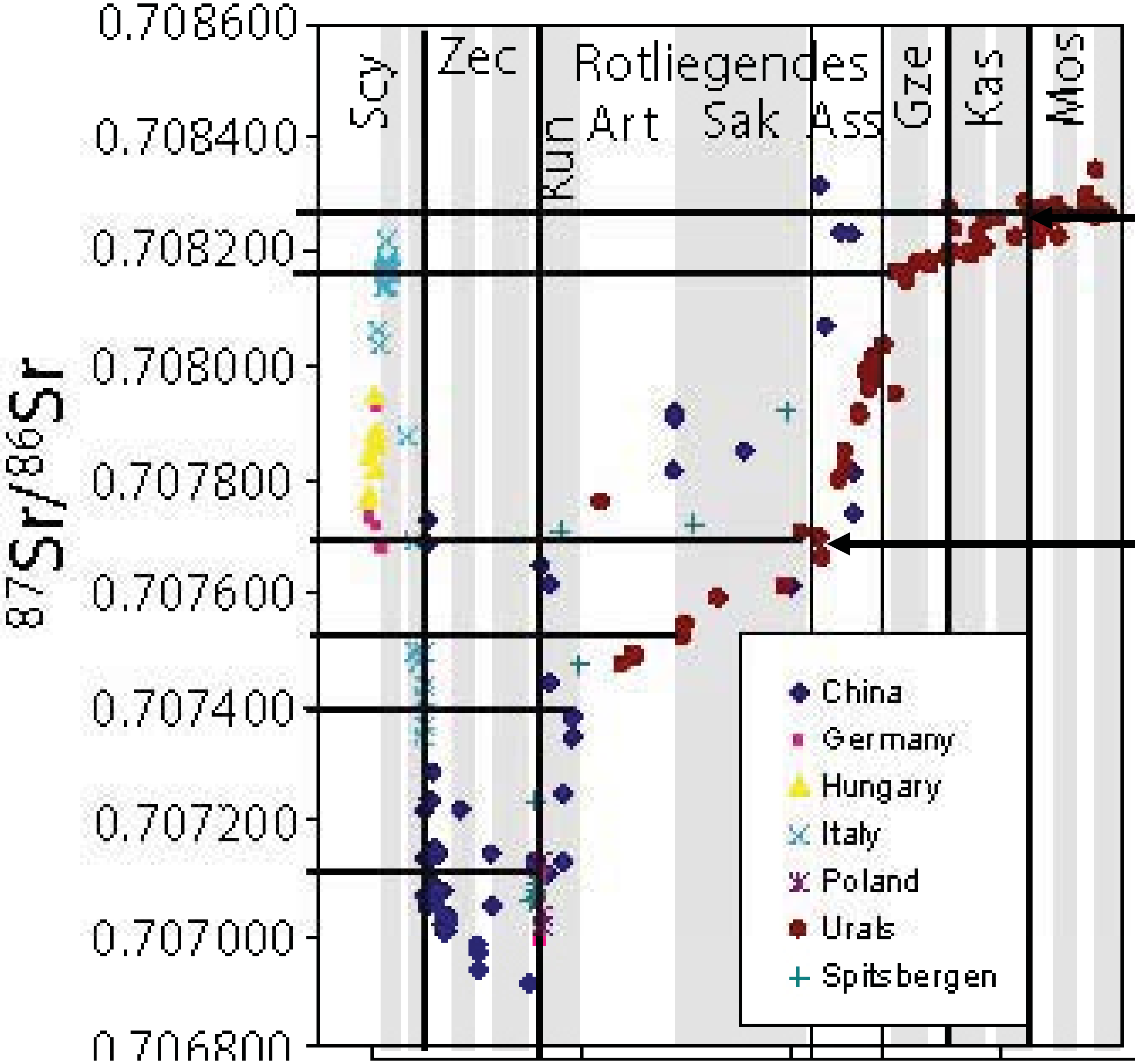
Typical cycle from the Central Basin Platform of the Midland Basin. The cycles range in thickness but are typically about 1 meter thick. They reflect forced regressions with subaearial exposure events. The cycles are deeper water near the base and show a typical shallowing-up sequence reflected in mud-rich carbonates changing upward into grainstones. The tops of cycles are marked by unconformities with evidence of soil formation. Calcretes from some of these cycle tops were dated by U-Pb, providing the age constraints for the present study.



Rasbury et al., in prep



Rasbury et al., in prep



Beginning of aridity
(in the tropics!)

Major transgression
End of cyclothems
(end of major glaciers?)

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