Subsidence and Eustatic Sea Level Records in the Stratigraphic Architecture of the U.S. Cretaceous Western Interior Basin*

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Abstract

Research over the past 15 years have established that the Cretaceous subsidence history of the Rocky Mountain region reflects a complex temporal and spatial interplay of long-wavelength dynamic subsidence related to mantle flow above the subducting Farallon slab, intermediate-wavelength subsidence across the foreland basin of the Sevier orogenic belt and short-wavelength and spatially complex subsidence and uplift related to the Laramide orogeny. Combined, these driving forces have created a Cretaceous sedimentary wedge that extends eastward more than 1500 km from the orogenic belt, generally thins eastward, and can be subdivided into megasequences by regional unconformities that closely relate to tectonic episodes in the thrust belt. Individual megasequences range in duration from 5 to 7 million years.

Superimposed on these regional tectonic drivers were global sea level fluctuations, which also imparted their signature on the stratigraphic architecture. Long-term global sea level rises and falls, now documented well in oxygen isotope data, are reflected in some major regressions and transgressions but appear to exert only a secondary role relative to temporal changes in regional subsidence rates. In contrast, sea level changes on the scale of Milankovitch cycles (104 to 106 years) are prominently expressed in the shallow and marginal marine strata.

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By

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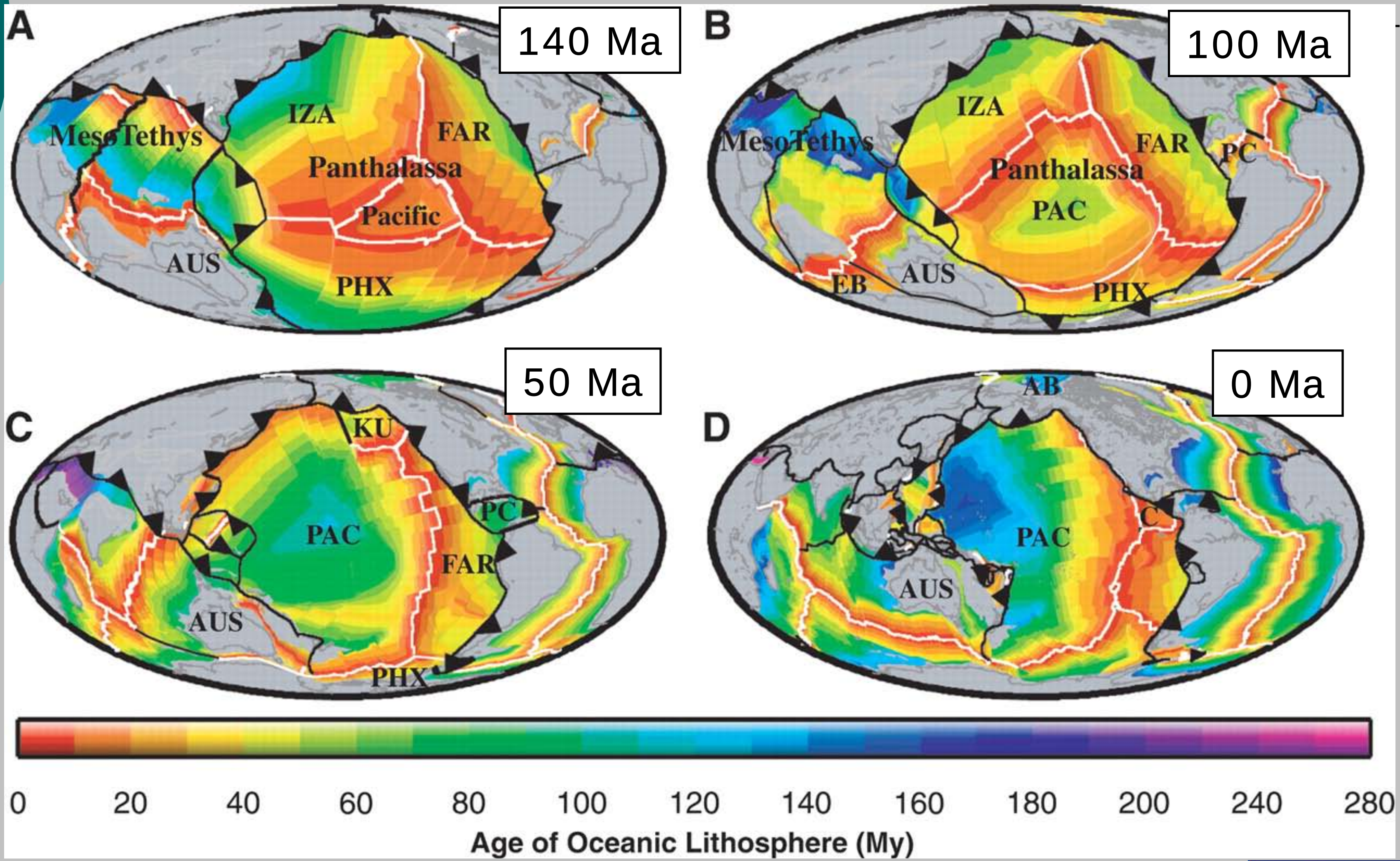
The Points

Accommodation space in the Cretaceous basins of the U.S. Rocky Mountains were generated by:

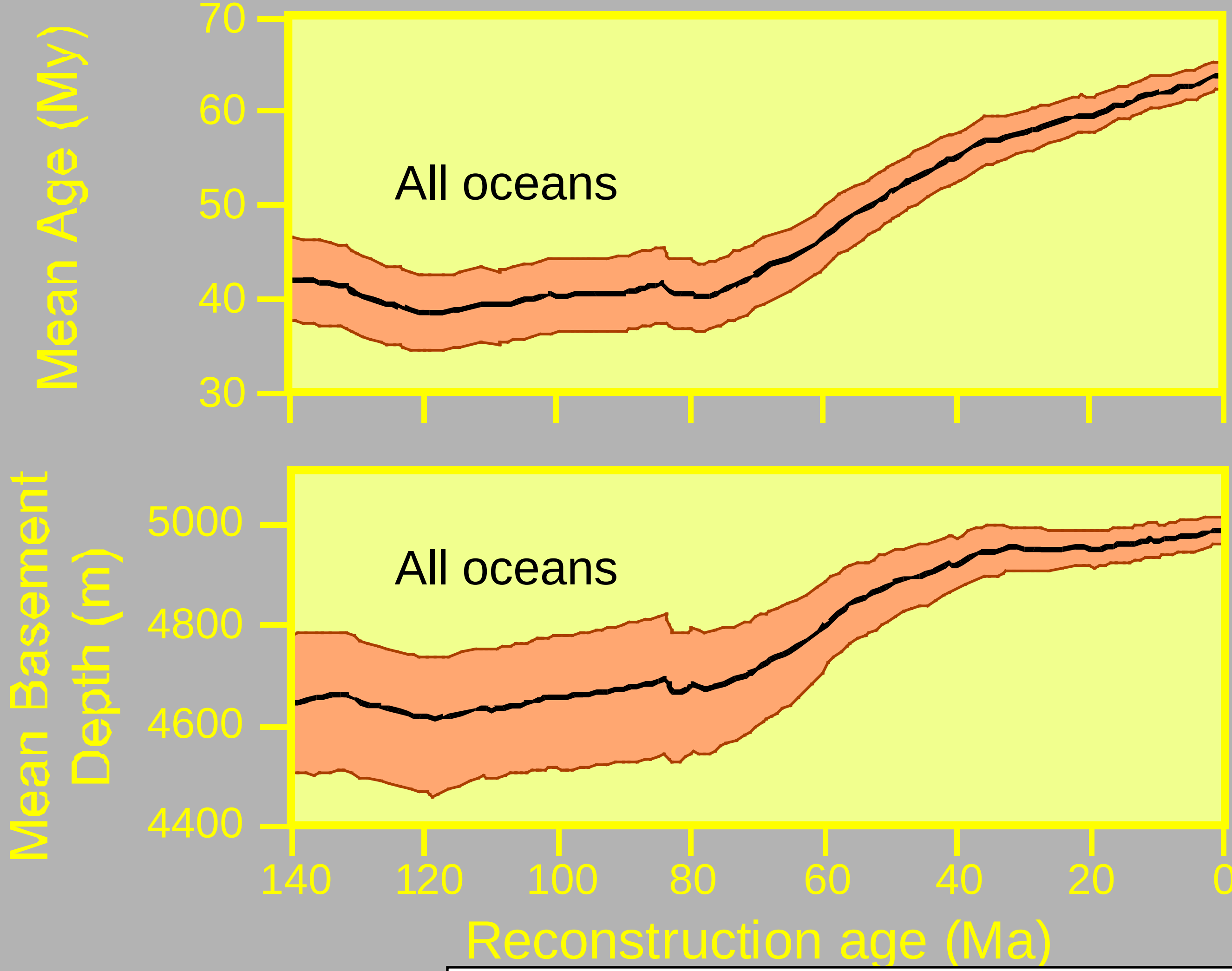
- Much higher global sea levels than today, because of younger seafloor crust
- Long-wavelength and long-term dynamic subsidence above the subducting Farallon plate
- Short-wavelength and intermittent flexural loading by the Sevier fold-and-thrust belt
- Very high-frequency eustatic sea level changes

Age-Area Distribution of the Ocean Floor

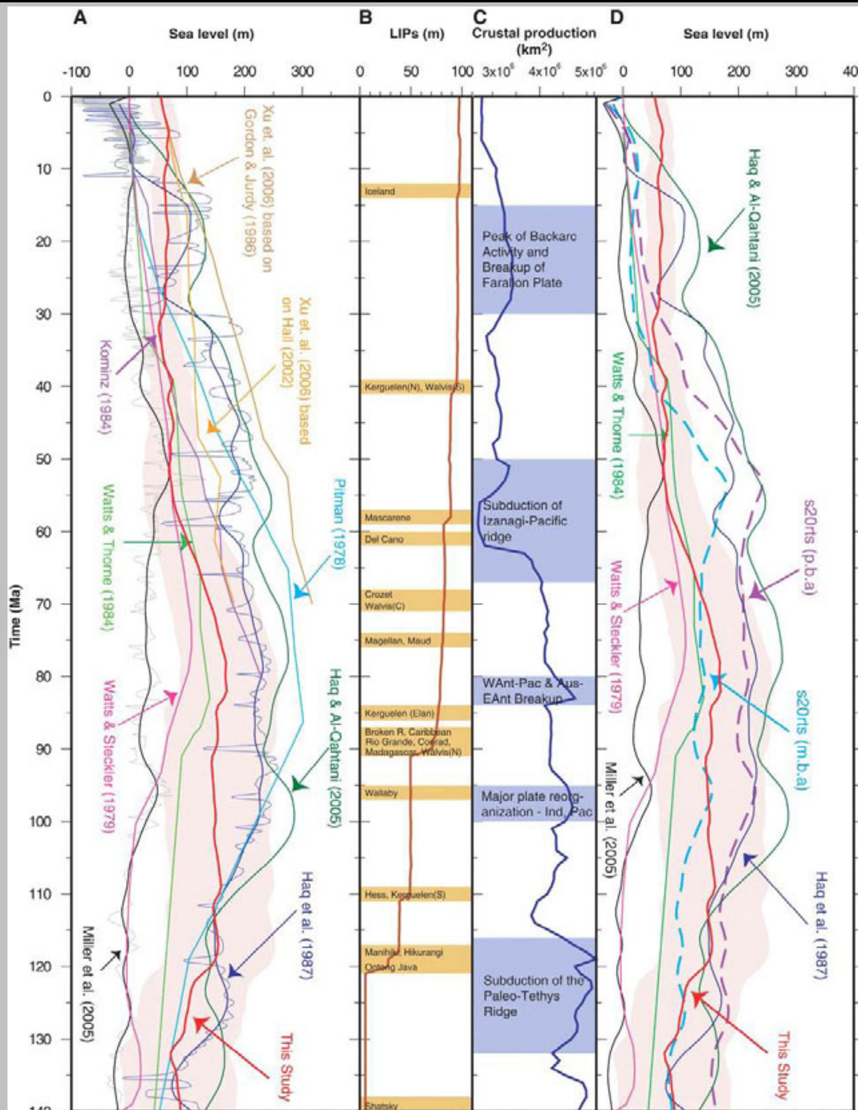


R. D. Muller et al., 2008 (c) AAAS used with permission

Changes in Ocean Depth



Long Term Sea Level Histories



Authors:

Pitman, 1976
Watts and Steckler, 1979
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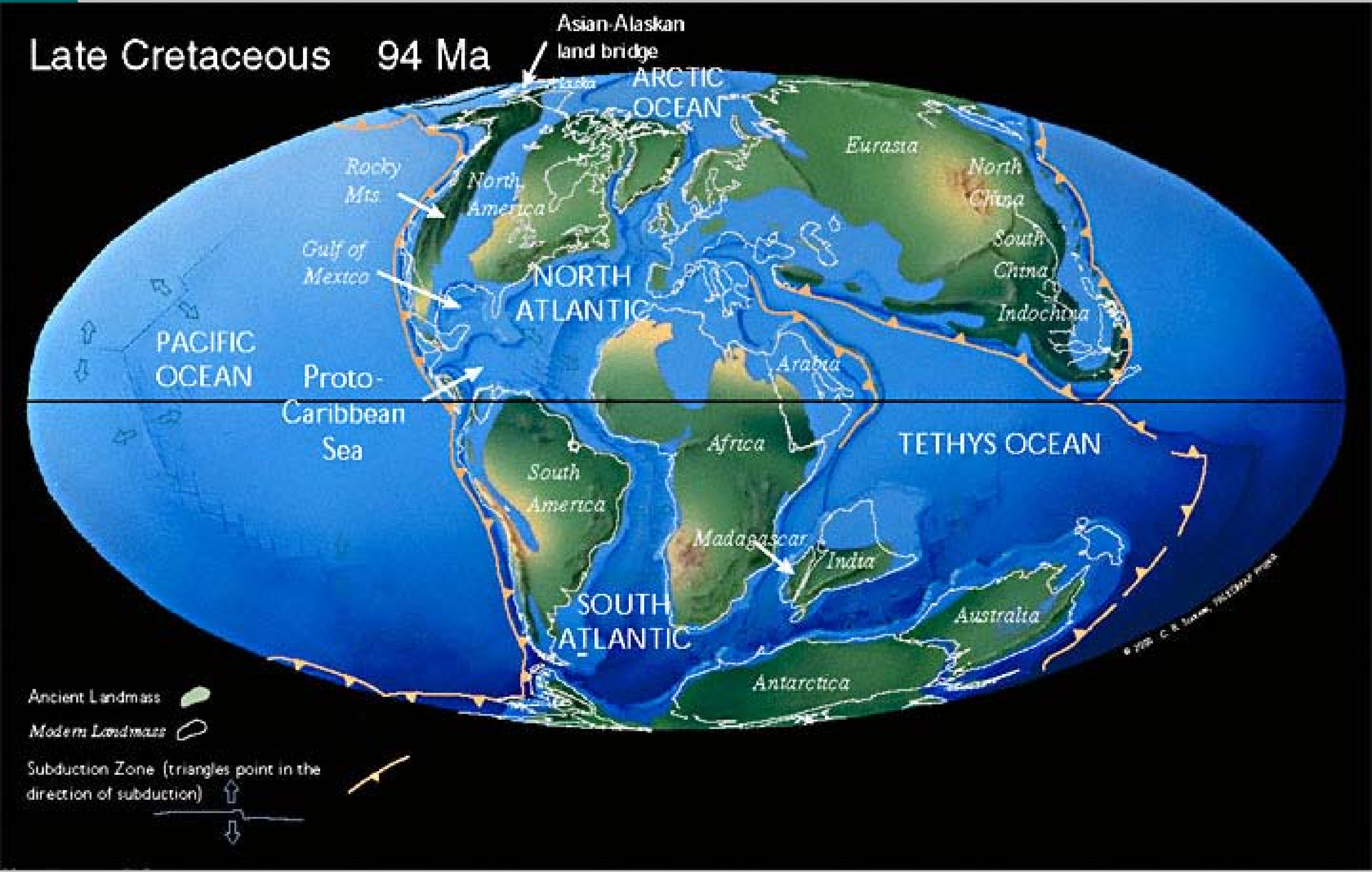
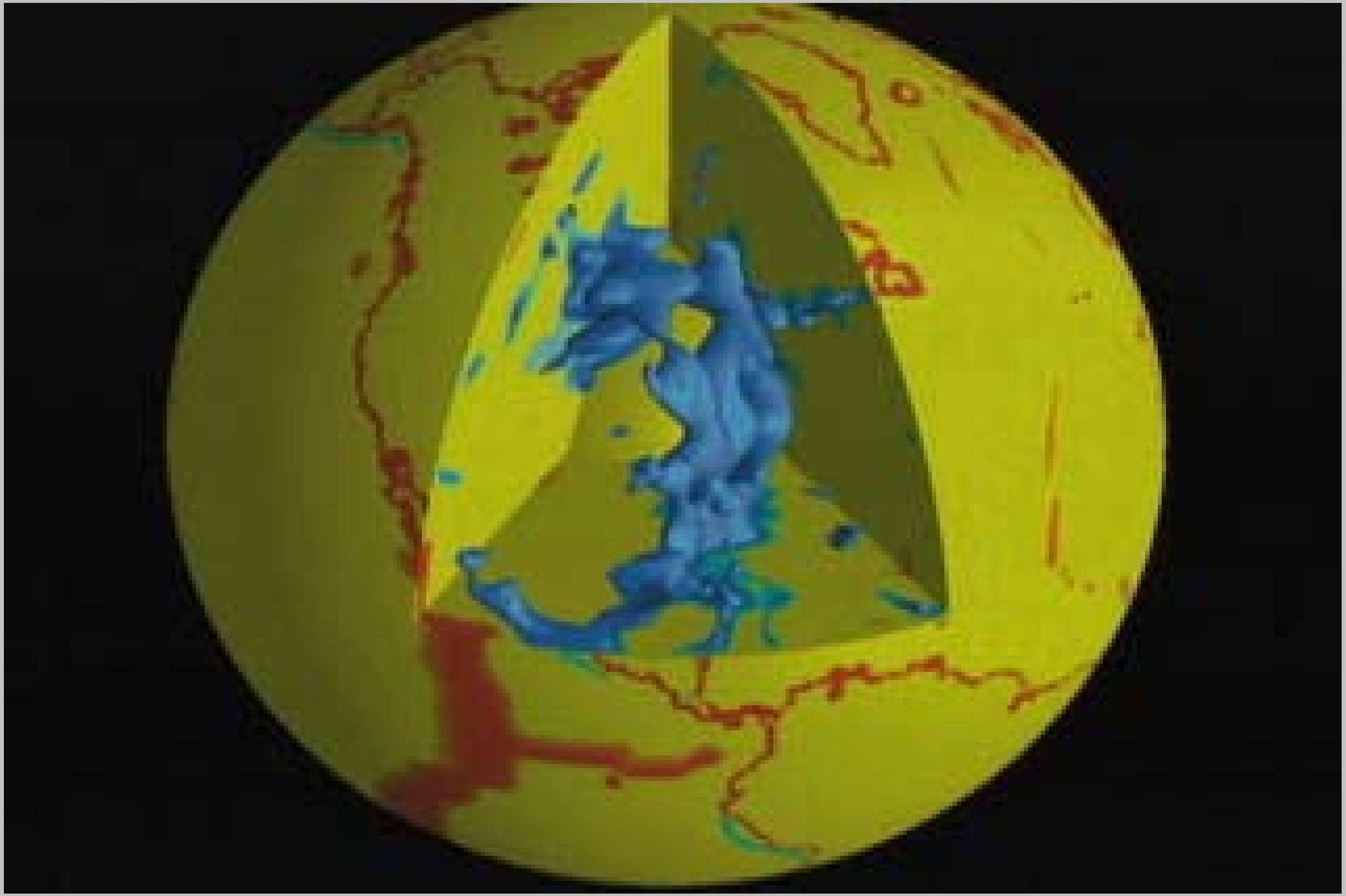
Kominz, 1984
Haq et al., 1986
Gordon and Jurdy, 1986
Miller et al., 2005
Haq and Al-Qahtani, 2006
Xu et al., 2006

Cenomanian Global Paleogeography

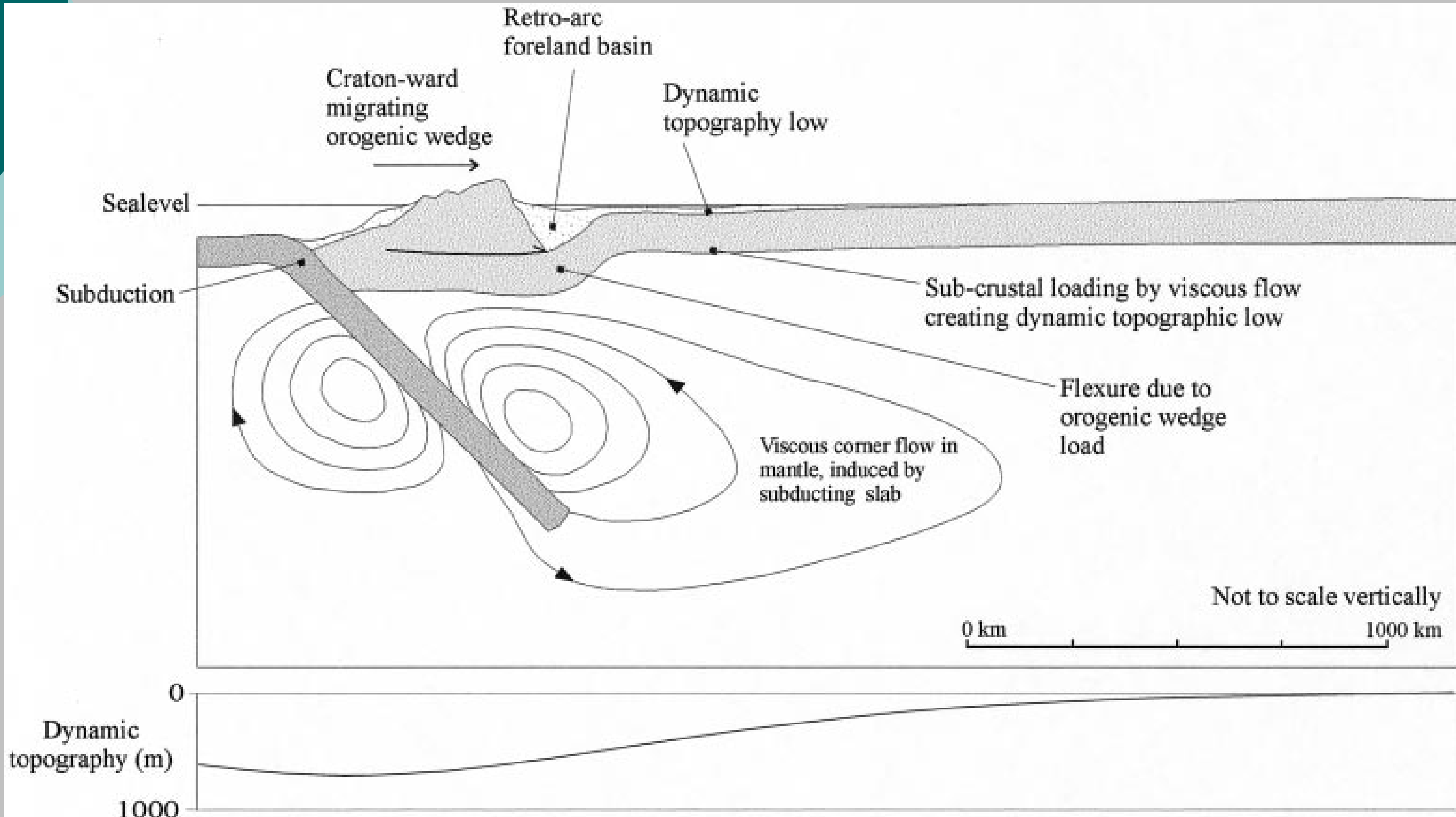


The Recycled Remnants of the Farallon Plate Today



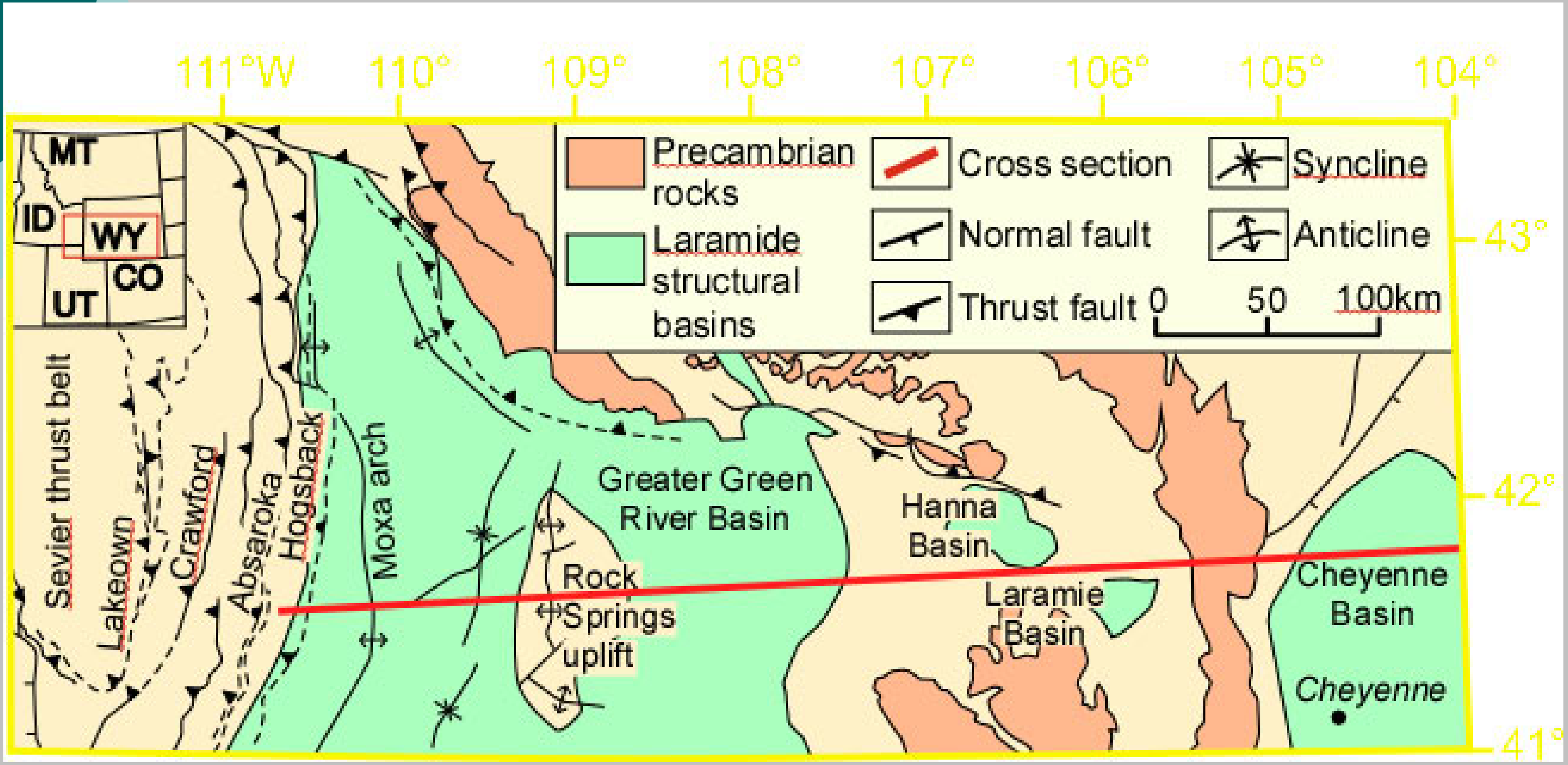
Web site of: Hans-Peter Bunge, Ludwig Maximilian University, Munich

Dynamic Topography Above A Subducting Slab

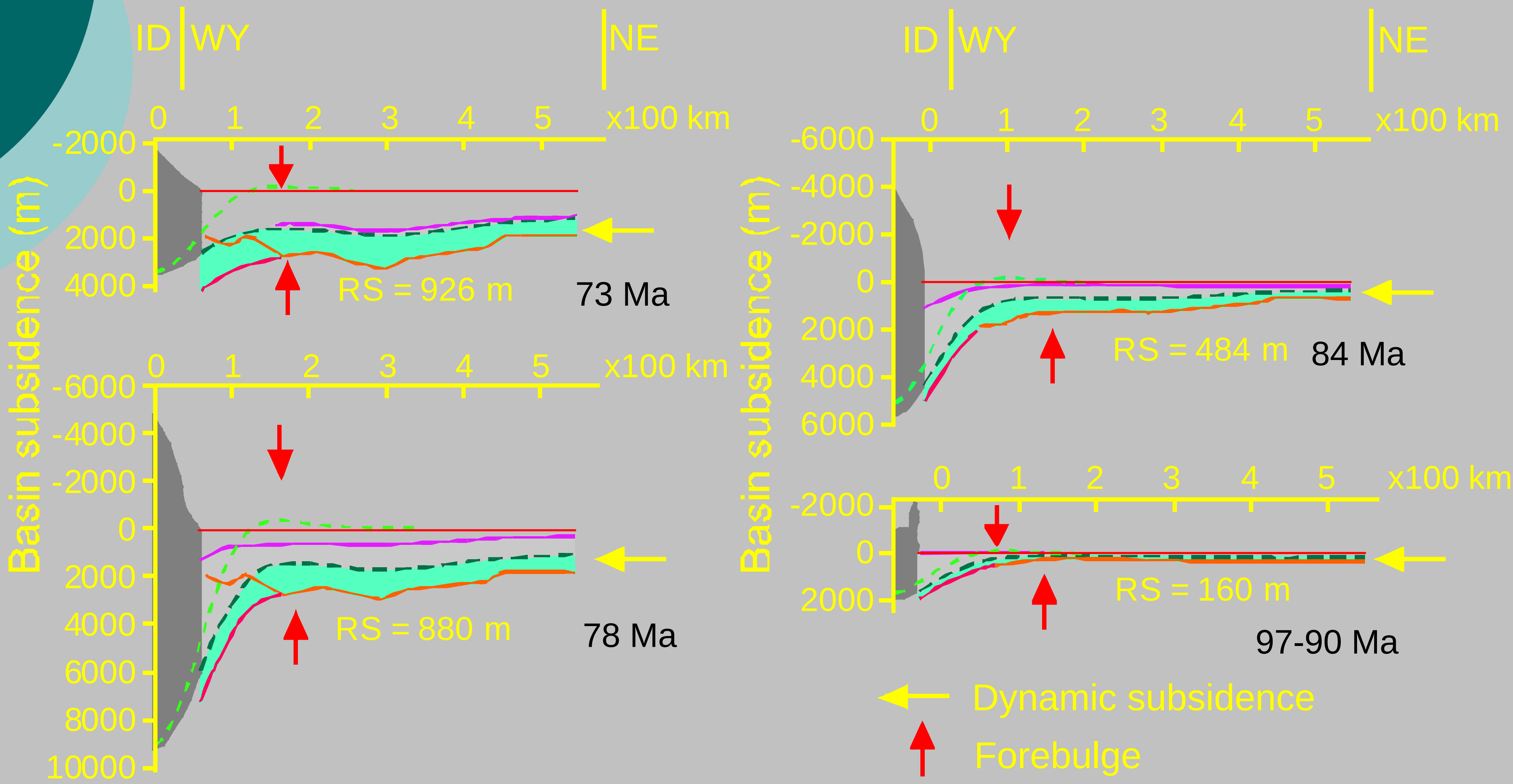


Burgess and Moresi, 1999

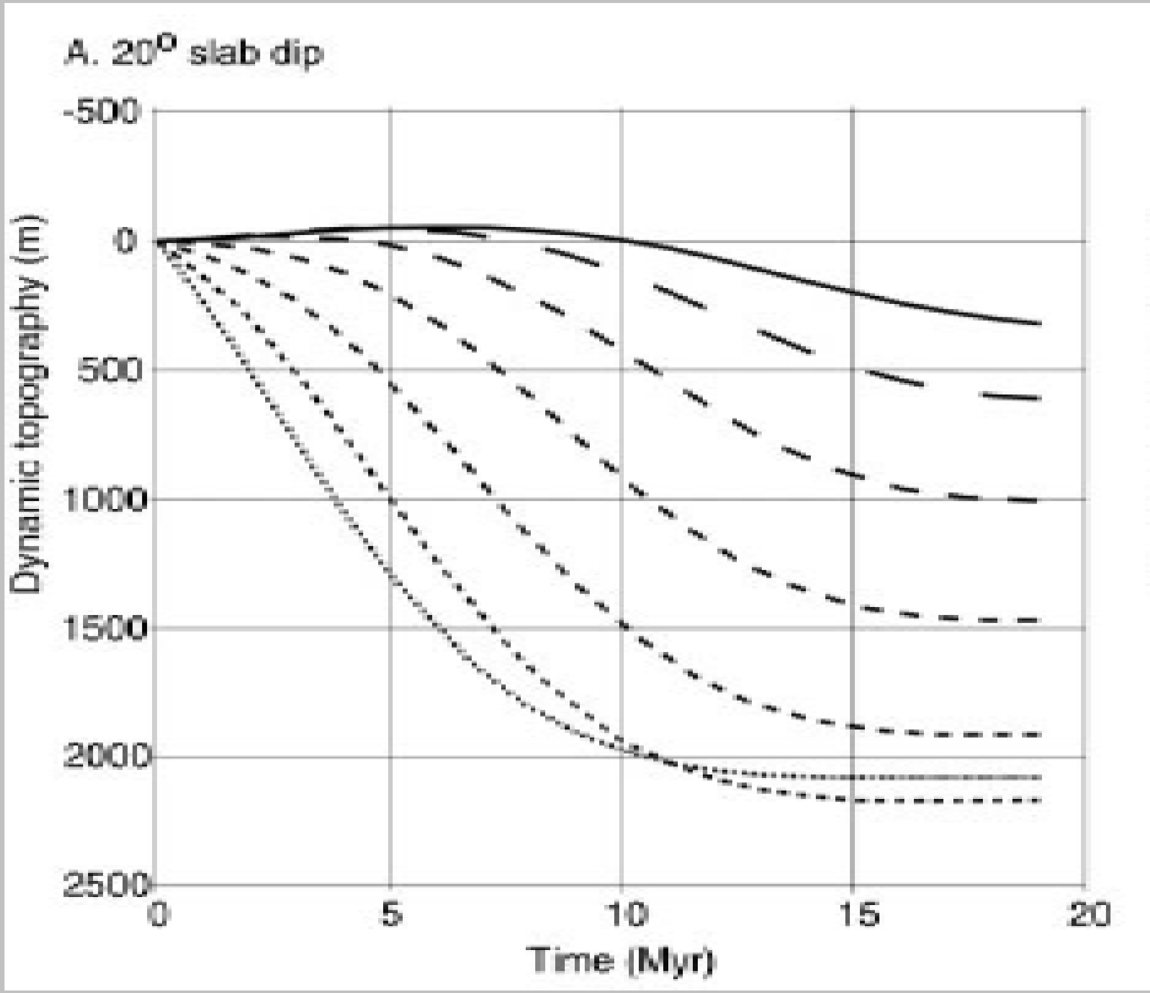
Modeled Cross Section Across Southern Wyoming



Total Subsidence Across Southern Wyoming

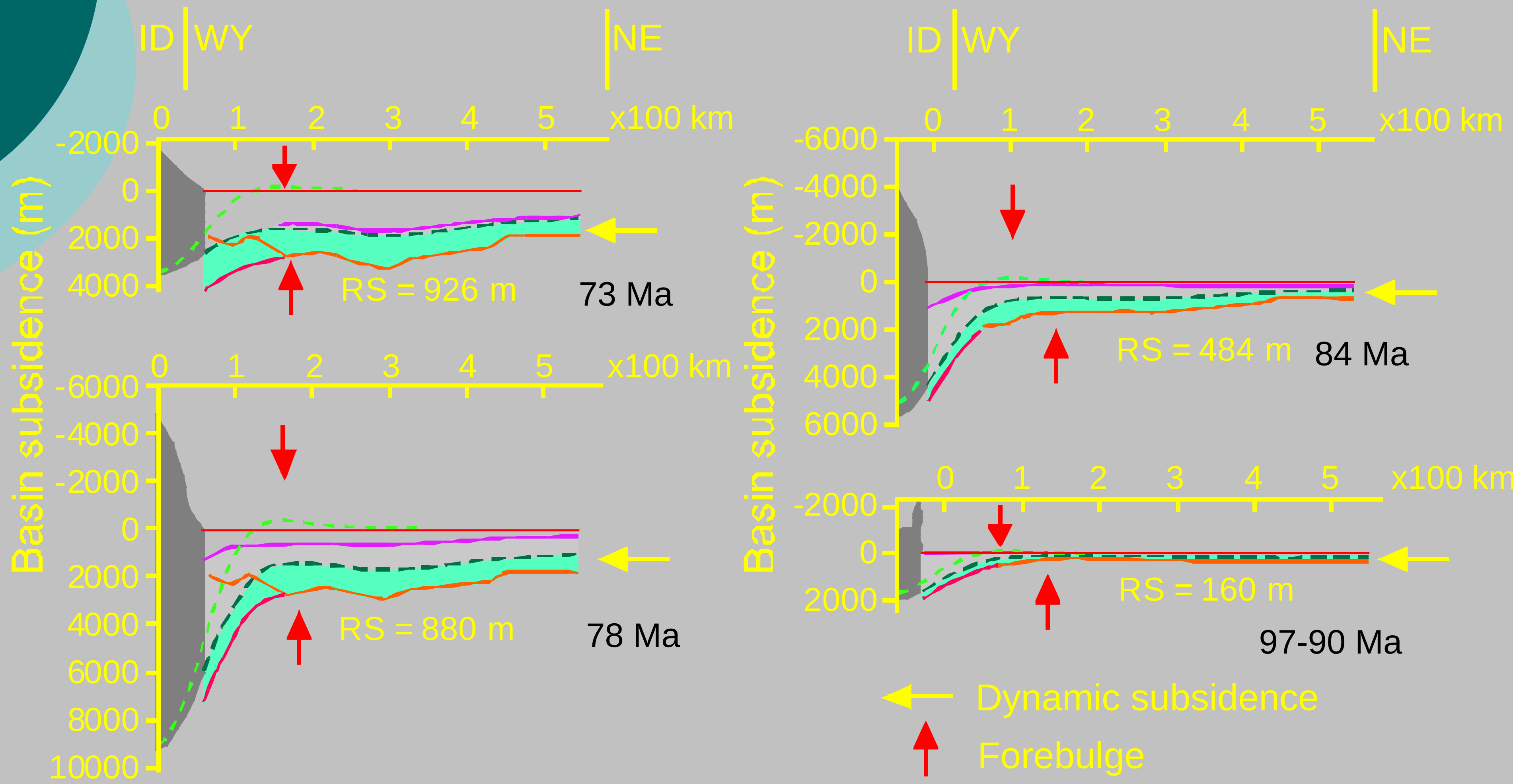


Rates of Change in Dynamic Subsidence

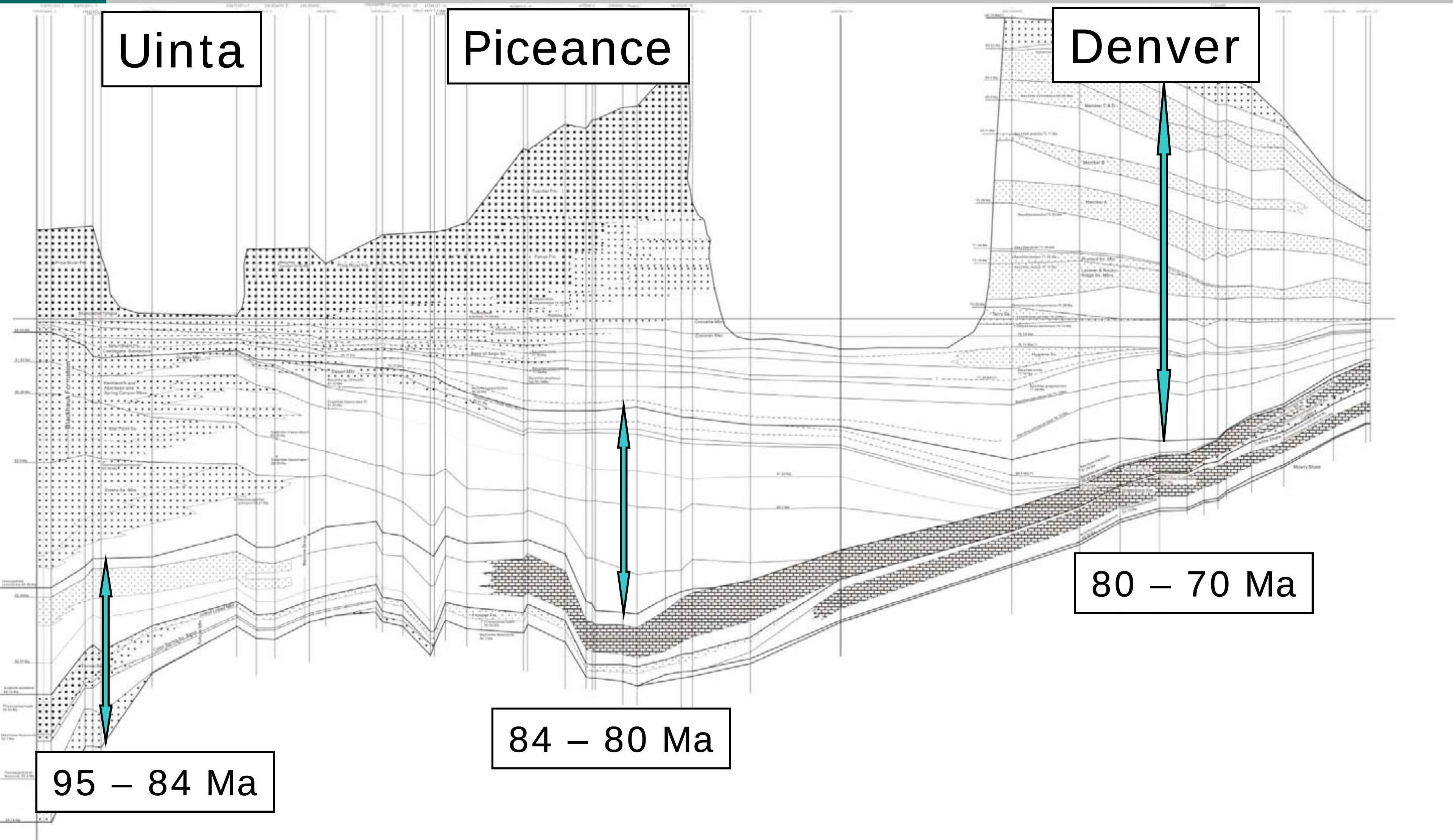


Burgess and Moresi, 1999

Total Subsidence Across Southern Wyoming



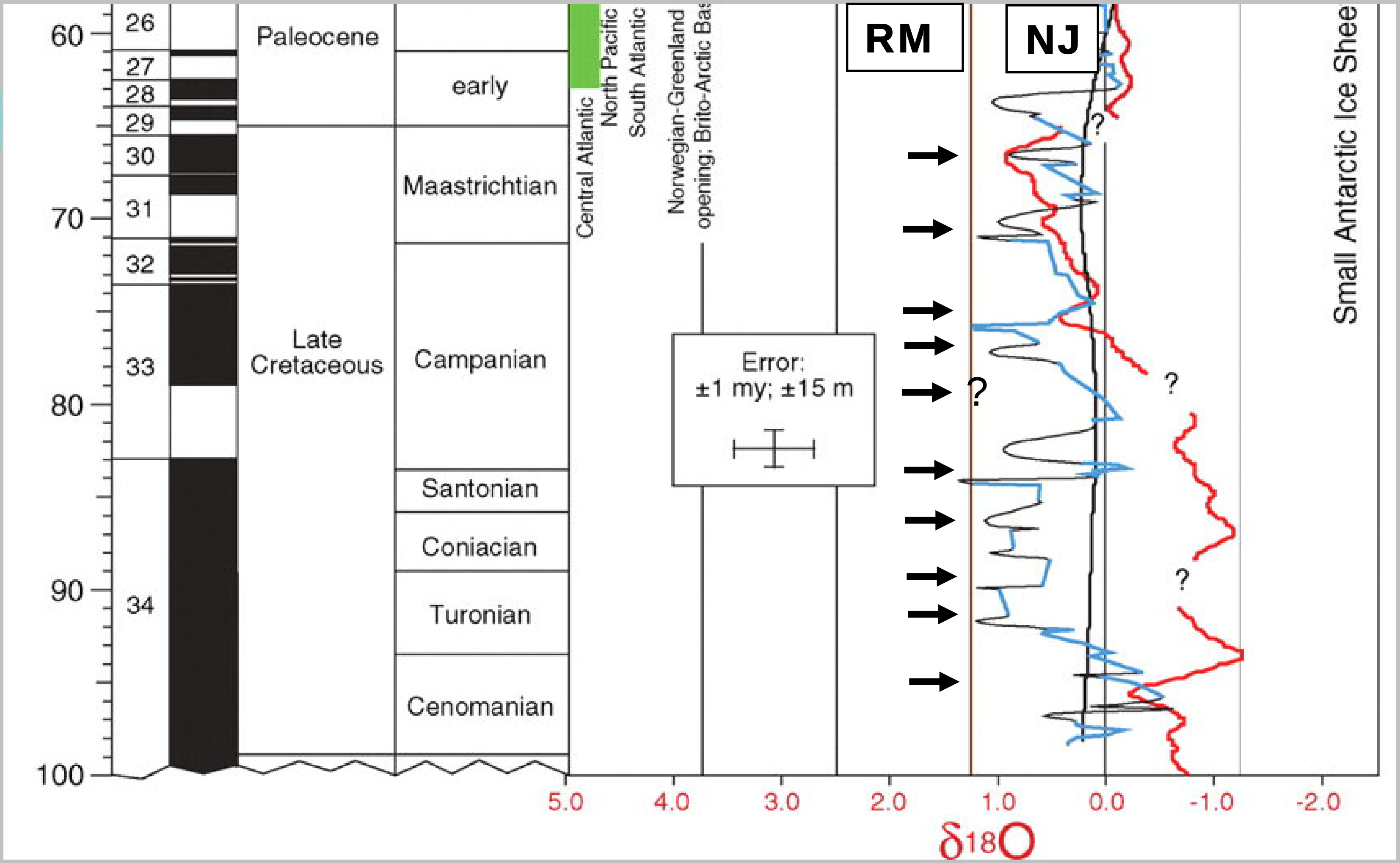
Utah-Colorado Cross Section



The Late Cretaceous Megasequence Boundaries

MS 10 – K/T boundary. Base Fort Union Fm.
MS 9 – Base Laramie Fm – 68.8 Ma
MS 8 – Base Sandstone Member A – 70.6 Ma
MS 7 – Terry SS - 75.1
MS 6 – Base Bluecastle Tongue - 77.0
MS 5 – Base Castlegate – 80.0 Ma
MS 4 – Upper Emery SS – 84.0 Ma
MS 3 – Lower Emery SS – 87.0 Ma
MS 2 – Base Coon Springs SS - 92.7
MS 1 – Base Dakota SS – 95.0 Ma

New Jersey Sea Level vs. Central Rockies



NJ data modified from Miller et al., 2005

Conclusions\Points

Accommodation space in the Cretaceous basins of the U.S. Rocky Mountains were generated by:

- Much higher global sea levels than today because of younger seafloor crust
- Long-wavelength and long-term dynamic subsidence above the subducting Farallon plate
- Short-wavelength and intermittent flexural loading by the Sevier fold-and-thrust belt
- These were punctuated by high-frequency sea level changes

Selected References

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