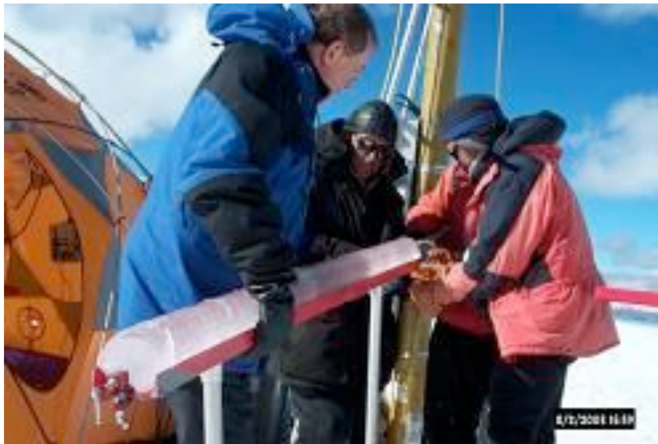


Paleoceanography I

Tools, Time Series, Time Slices

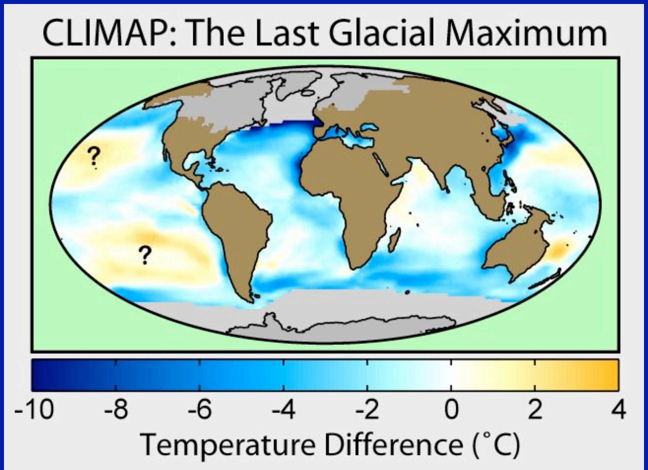
Geological Oceanography

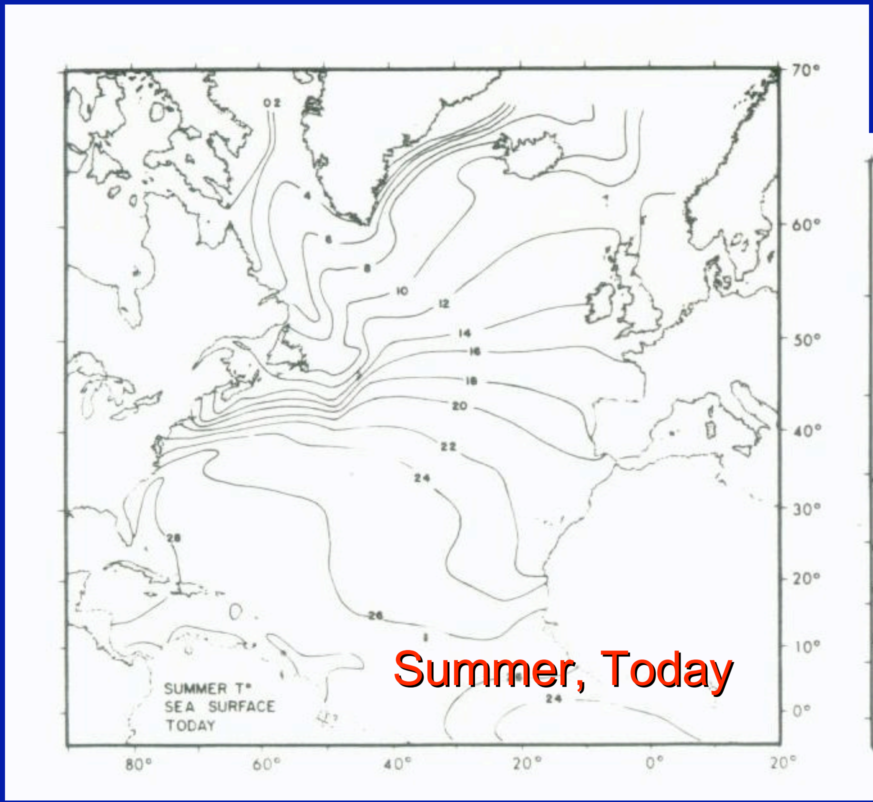
OCN 622

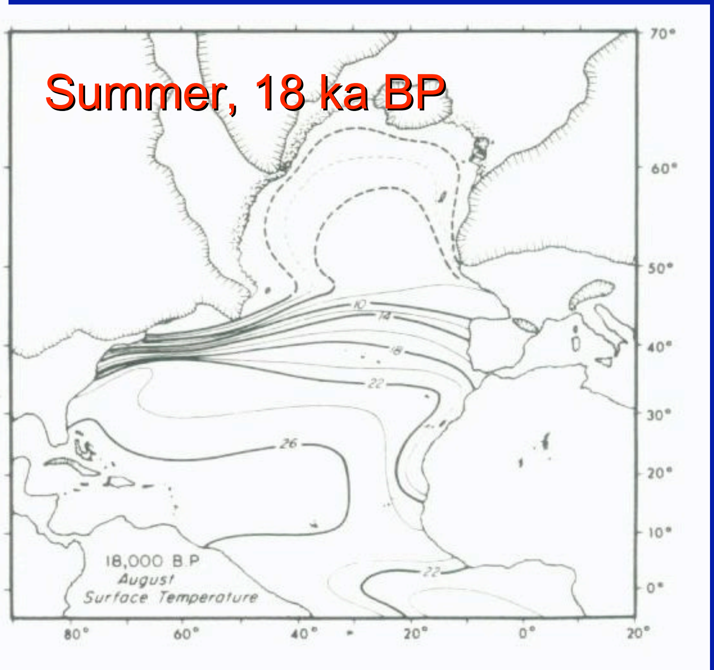
Gary McMurtry

Paleo-reconstructions

CLIMAP Project: Reconstruction of Earth's Climate at Last Glacial Maximum (18 ka BP)

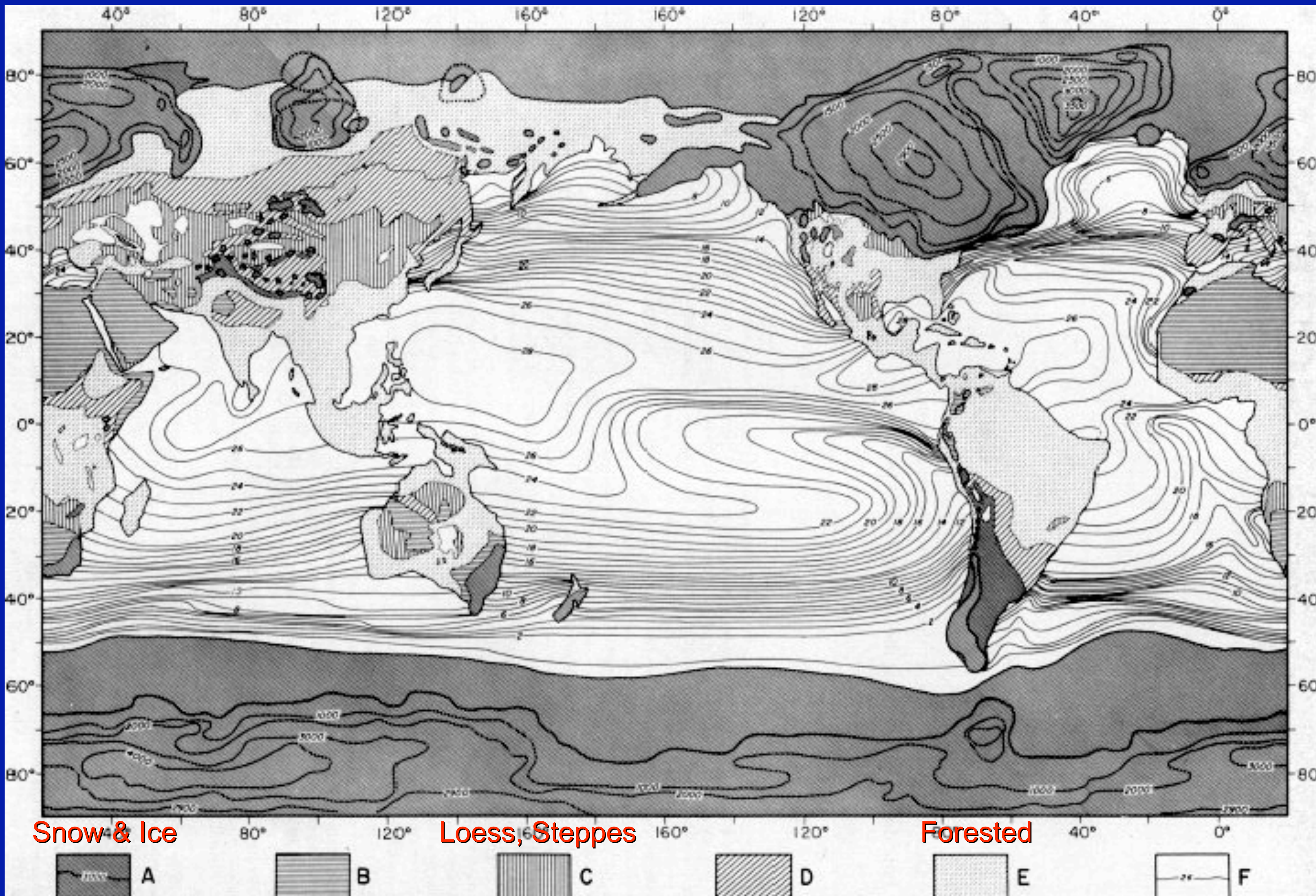






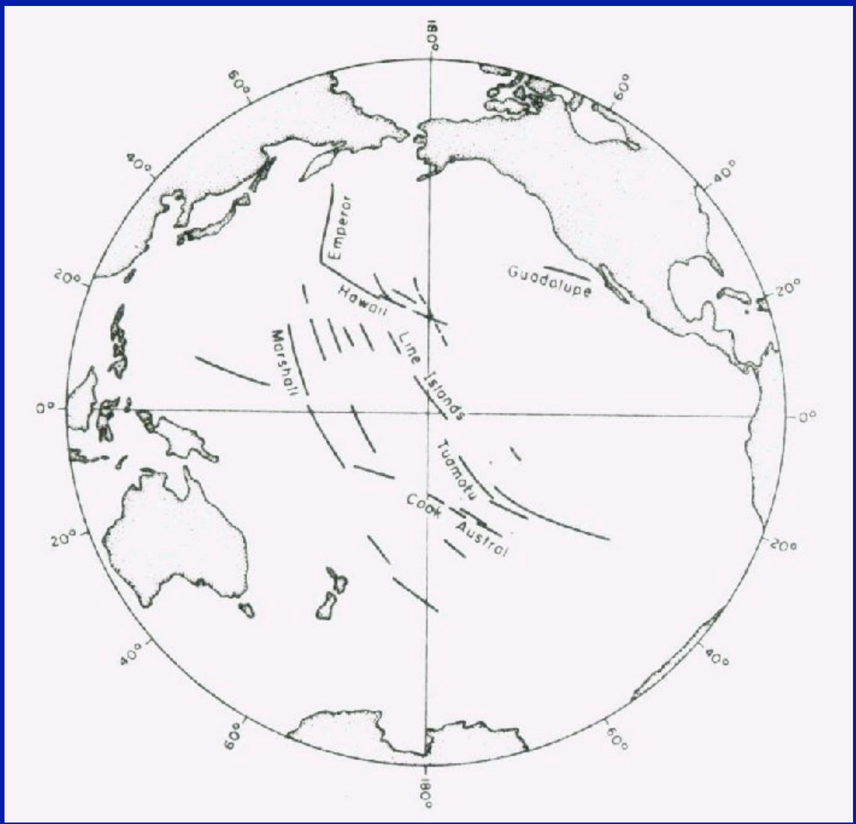
Paleo-reconstructions

From: CLIMAP, Science (1976)

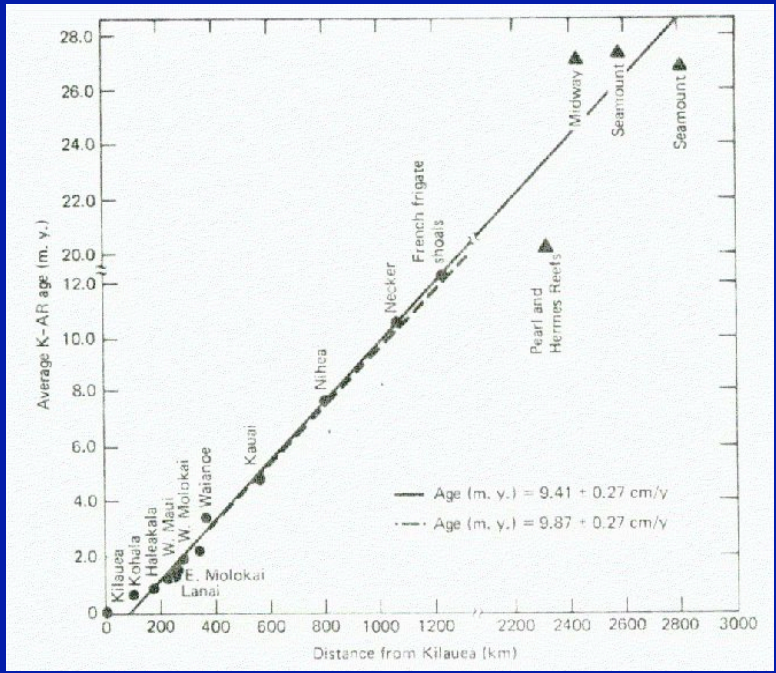


Hot Spot Trails

Volcanic lineations in the Pacific

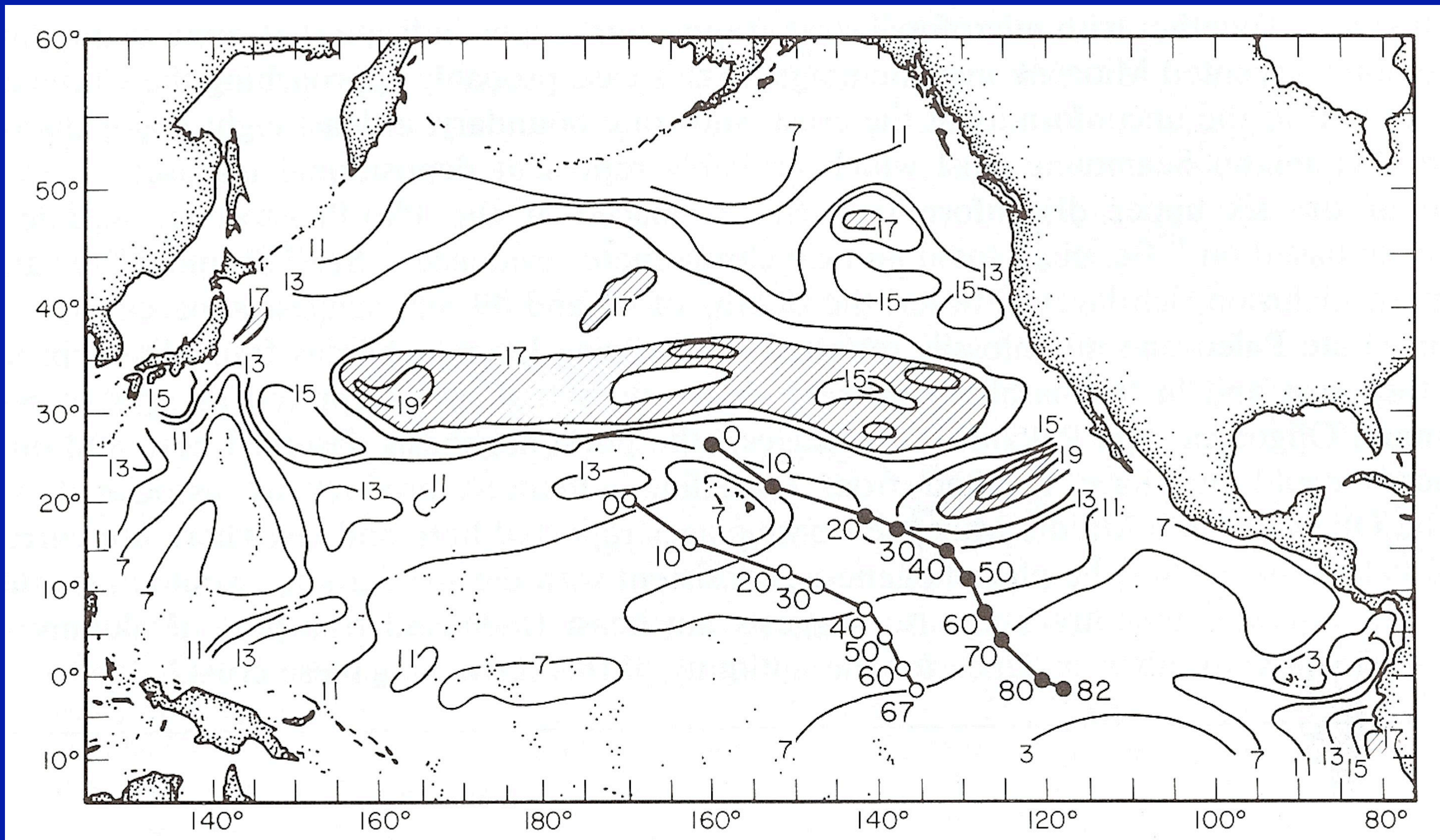


From: Kennett (1982)



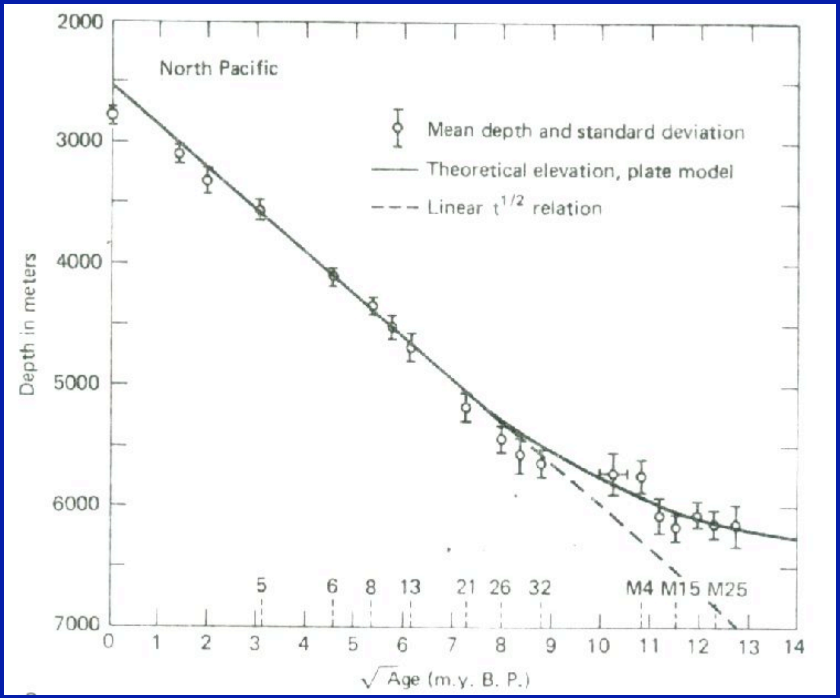
Plot of K-Ar age of shield-building volcanism vs. distance from Kilauea

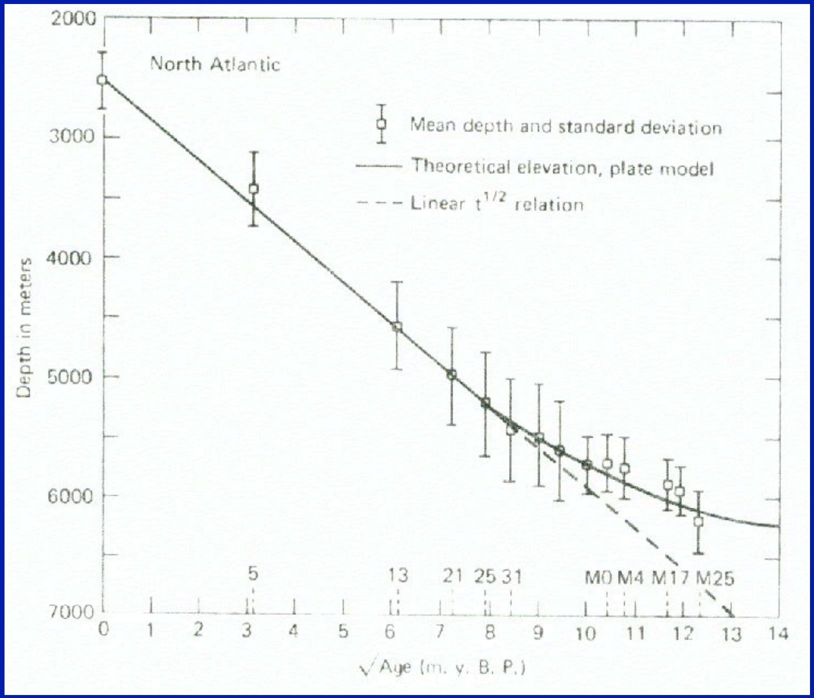
Seamount Paleo-track



From: McMurtry et al. (1994)

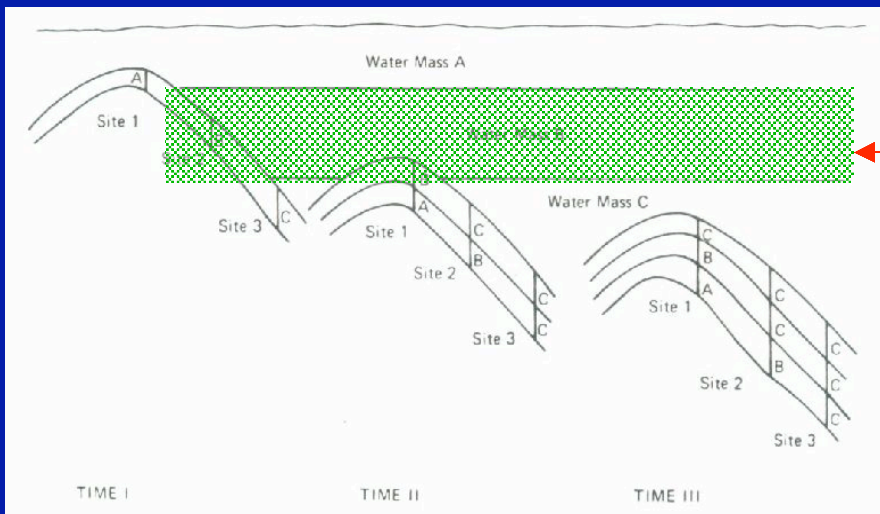
Lithospheric Cooling & Subsidence





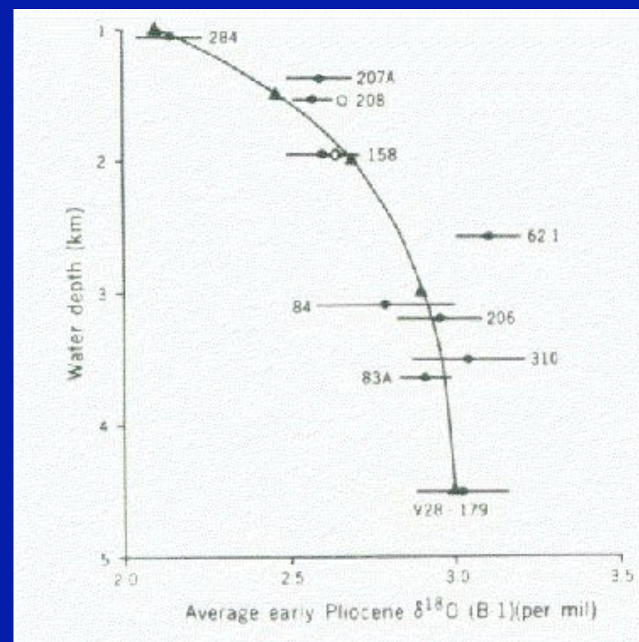
Parsons & Sclater (1977)

Working Backwards at Vertical Ocean Structure



Say, the oxygen minimum zone

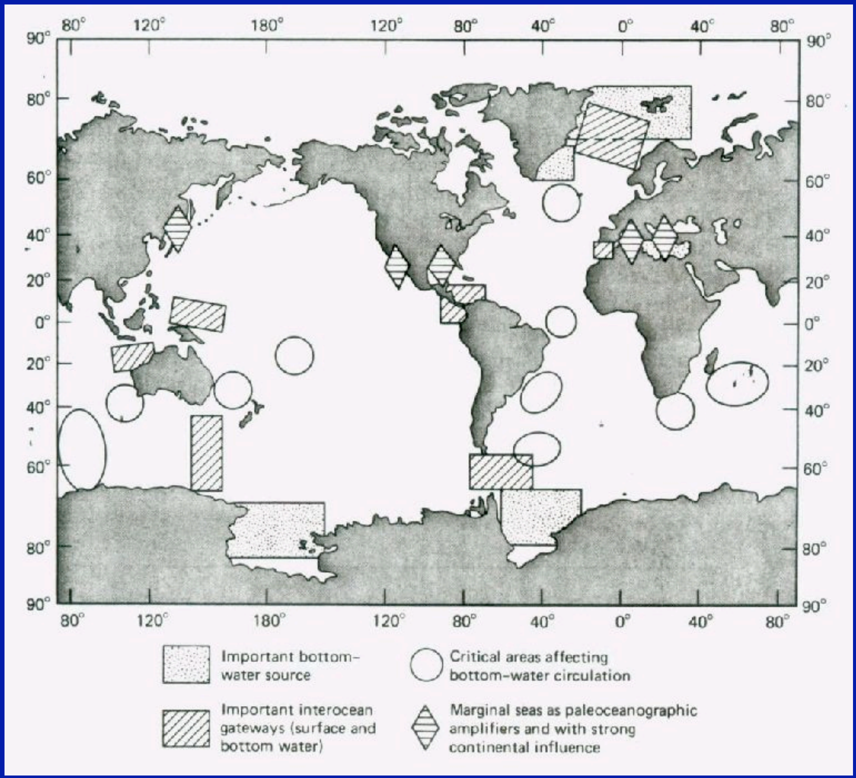
Three time slices showing the influence of 3 vertically-stable water masses on a subsiding ridge, seamount.



Early Pliocene $\delta^{18}O$ versus water depth recorded in DSDP core sites.

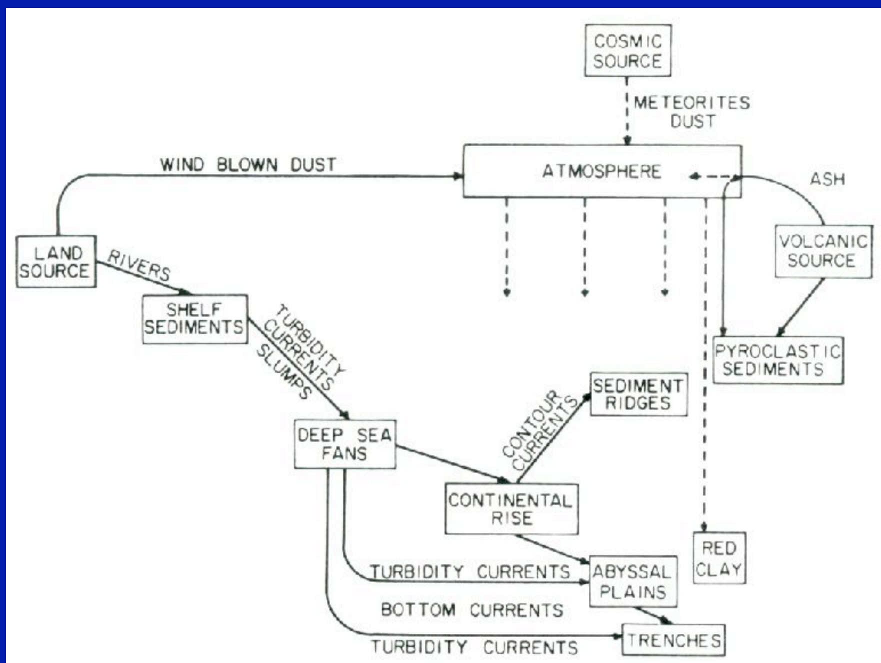
Optimal & Critical Areas for Studying World Ocean History

	Vertical	Horizontal	"Gateways"
Deep sea	Ridge flanks Plateaus Guyots and other aseismic elevated features	Frontal regions Convergences and divergences	On flanks and in basins downstream from passage
Marginal	Offshore margin monitors Subsiding offshore platforms Intersections of aseismic ridges with continental margins Deep-sea margin transition	Eastern boundary currents Western boundary currents Antarctic deep currents	



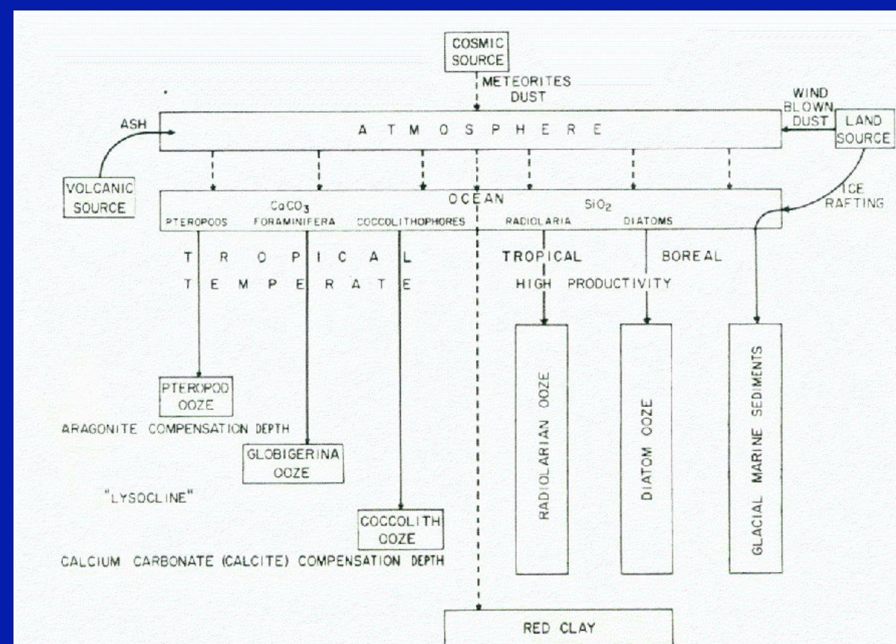
From: Kennett (1982)

Types of Sediments Available & Their Origins: Summary Charts



Clastic (detrital) Sediment Processes

Useful Summary Diagrams
From W. W. Hay (1974)



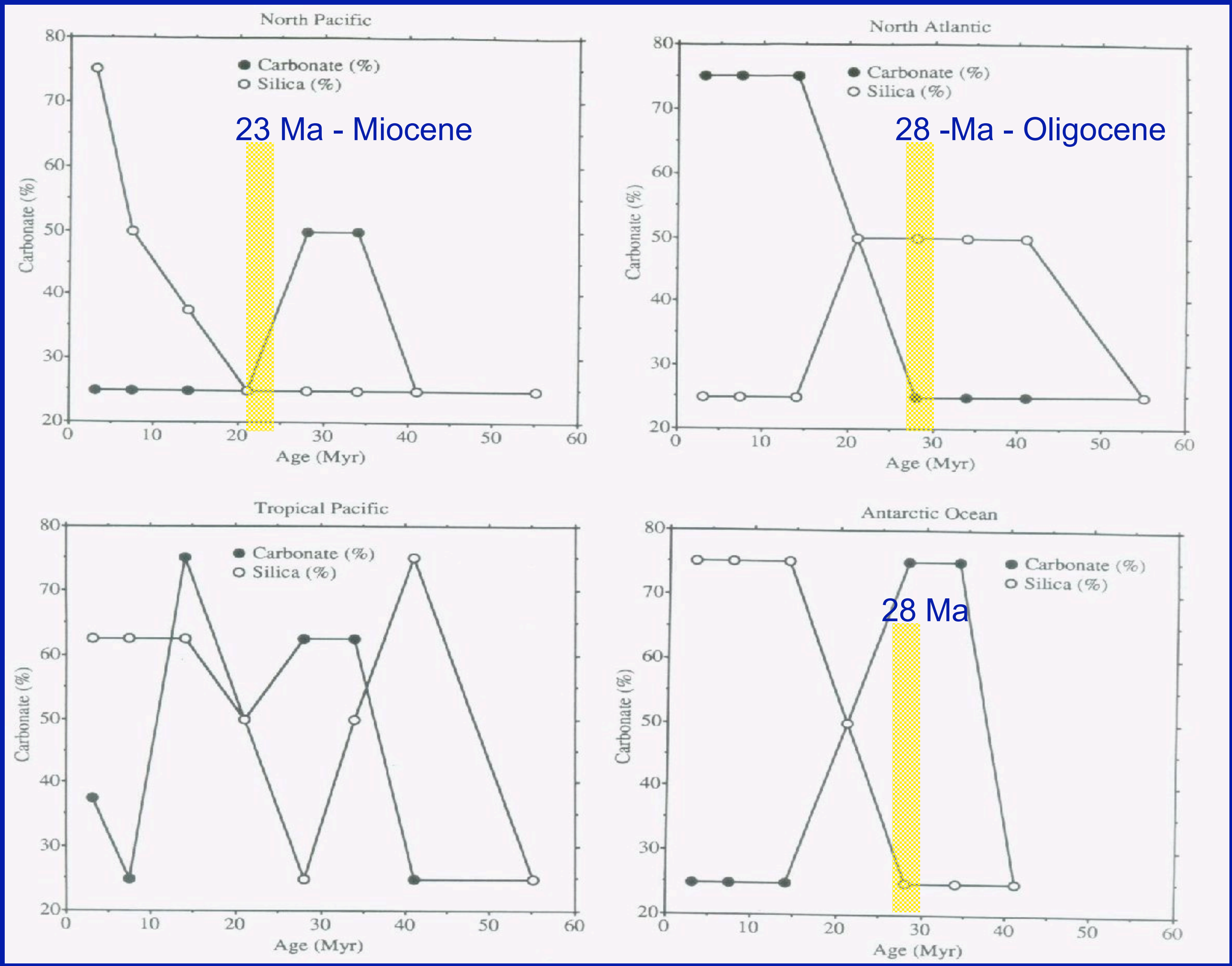
Pelagic Sedimentation in the Oceans

Biogenic Silica & Carbonate: changing patterns in the Cenozoic

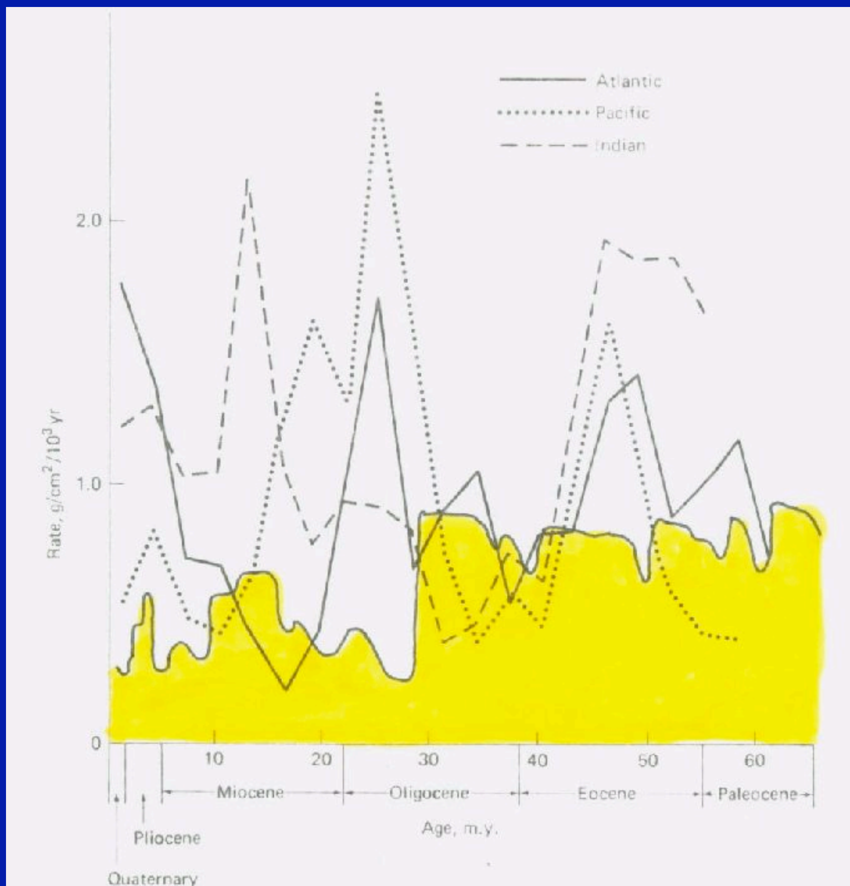
	Antarctic		Tropical Pacific		North Pacific		North Atlantic	
	carb	silica	carb	silica	carb	silica	carb	silica
Quaternary and Pliocene	L	H	M to L	M to H	L	H	H	L
Late Miocene	L	H	L	M to H	L	M	H	L
Middle Miocene	L	H	H	M to H	L	L to M	H	L
Early Miocene	M	M	M	M	L	L	M	M
Late Oligocene	H	L	M to H	L	M	L	L	M
Early Oligocene	H	L	M to H	M	M	L	L	M
Middle to Late Eocene	L	L	L	H	L	L	L	M
Early Eocene and Paleocene	?	?	L	L	?	L	L	L

Source: T. C. Moore, Jr.

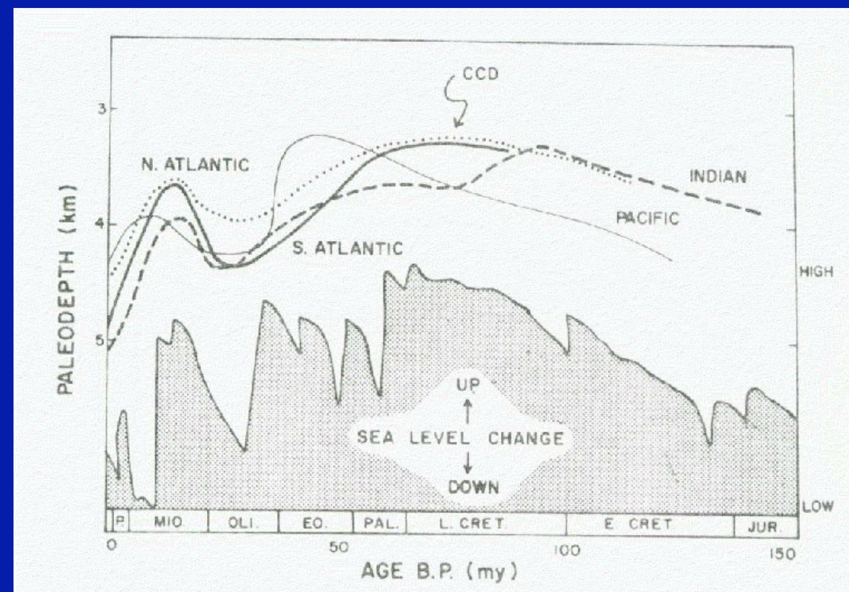
Plots of T. C. Moore's Chart



Temporal Changes of Sedimentation & the CCD: Relations to Sea Level



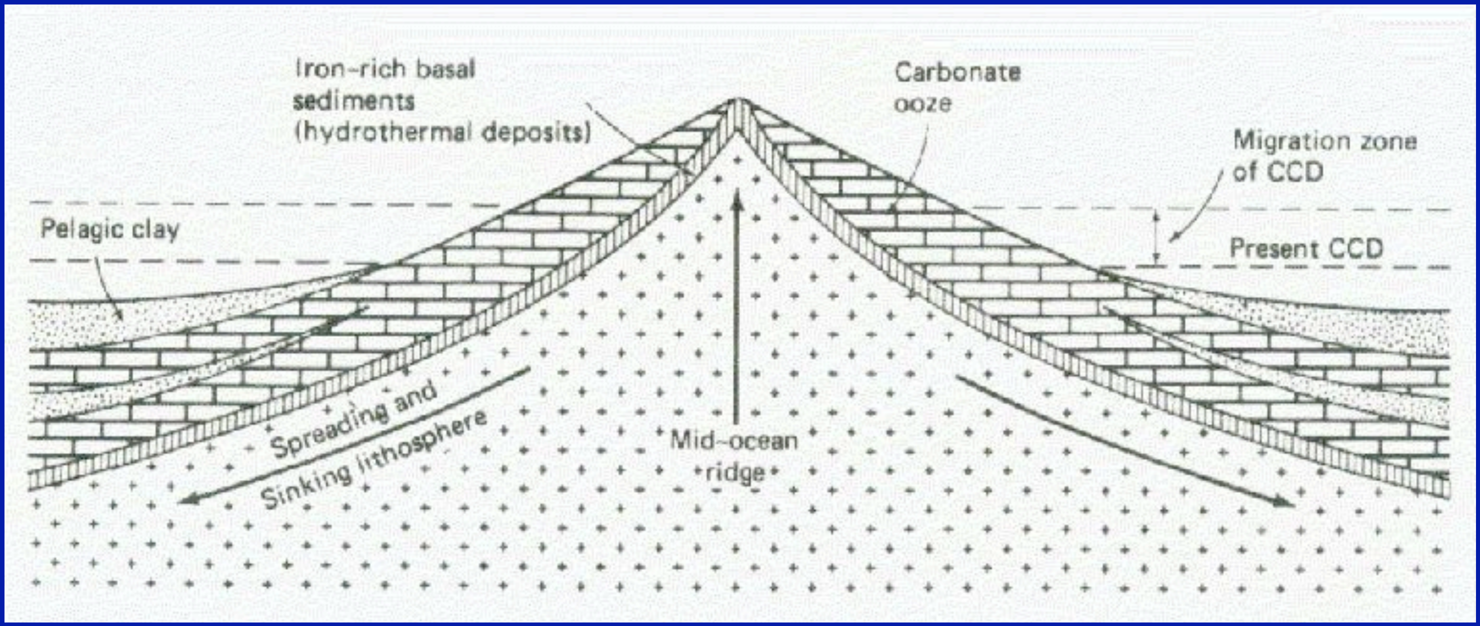
Ocean Sedimentation vs. Sea level
(from T. A. Davies, 1981)



Variations in paleo-CCD for the Pacific, Indian & Atlantic Oceans for past 150 Ma
(from van Andel, 1979)

High sea level => acidic oceans
Low sea level => alkaline oceans

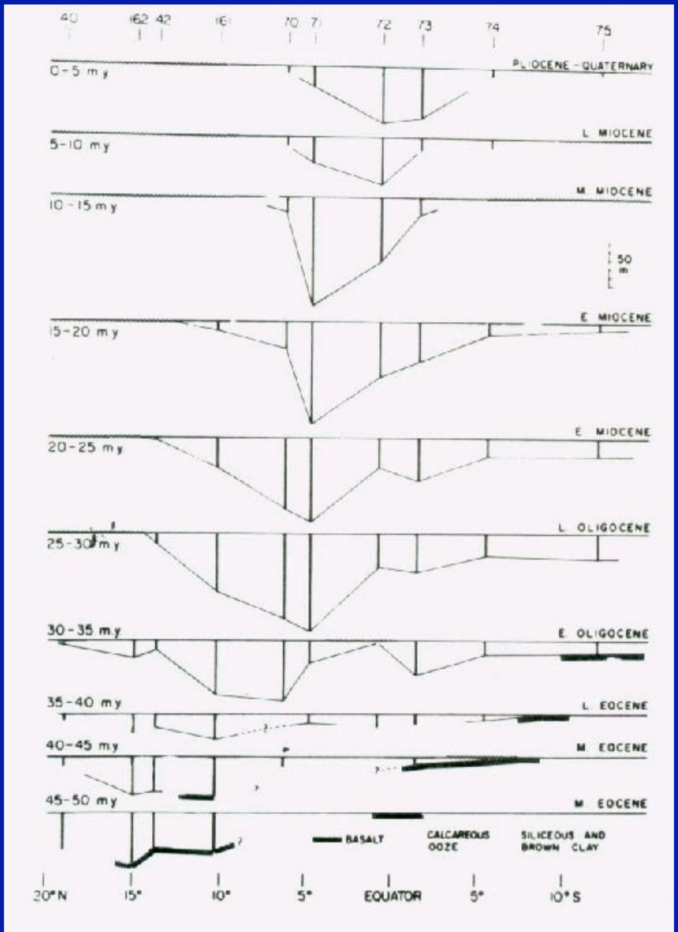
Plate Tectonics & Sedimentary Facies



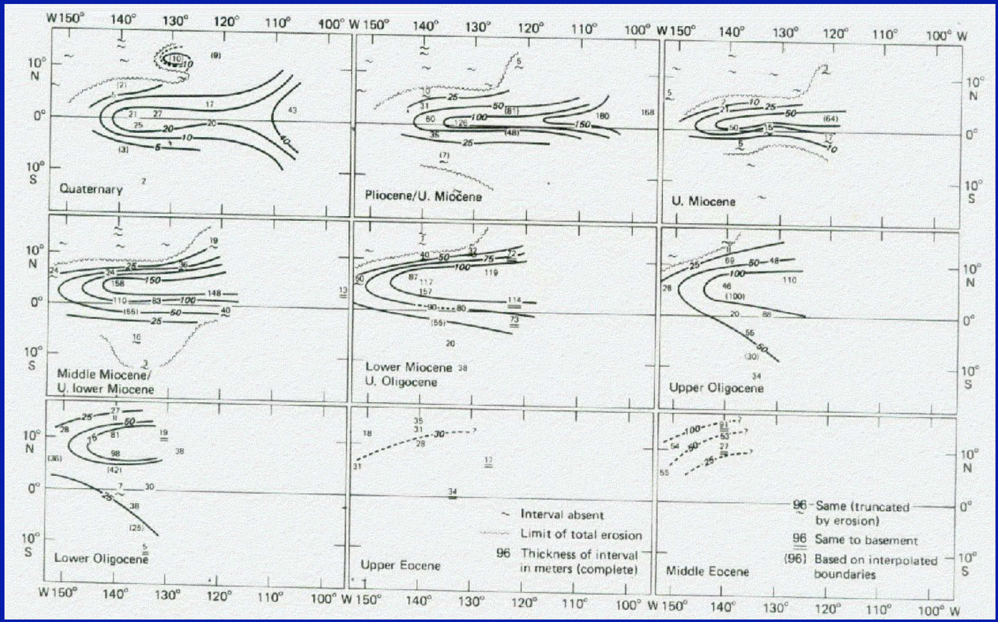
Interfingering of layers due to variations in the CCD level

Berger et al. (1976)

Plate Tectonic Effects on the Equatorial Pacific



Left: Time Slices of Sediment Thickness Variations

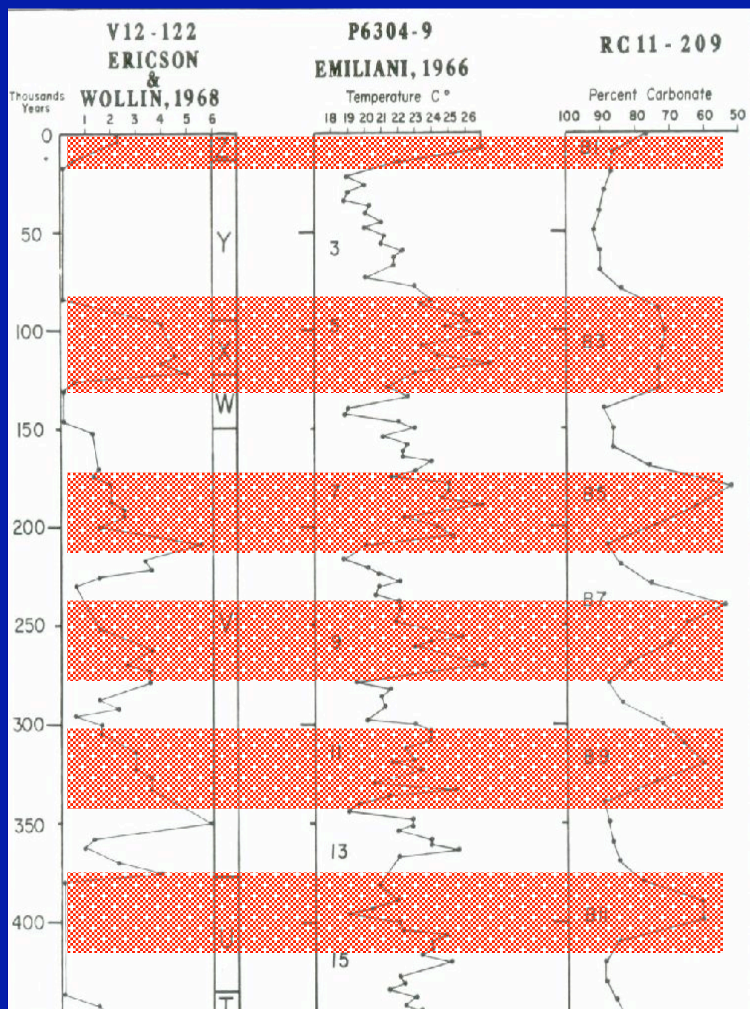


Above: Time Slices of Sediment Thickness as Isopach Maps

Plate motion

Kennett (1982)

Carbonate vs. Two Paleo-temperature Curves for the Late Quaternary



Hays et al. (1969)

High carbonate = alkaline ocean = cold, glacials

Low carbonate = acidic ocean = warm, interglacials (red)

Enter the Bugs: Morphologies of Tests Can Provide Relative Age & Climate Data

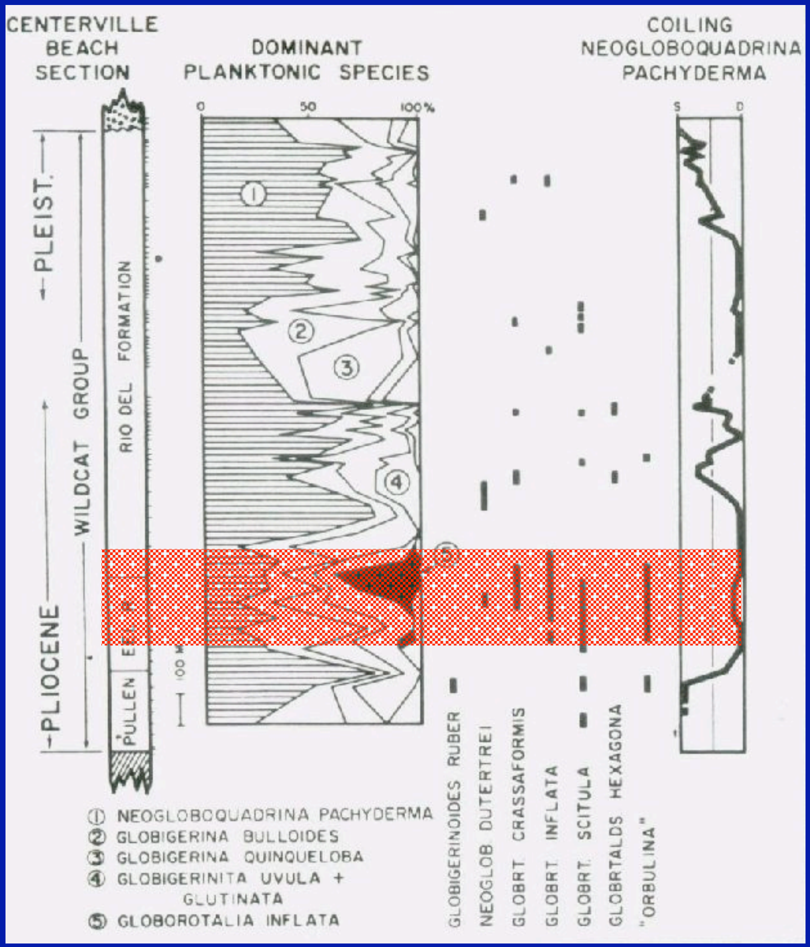
	Foraminifera	Radiolaria	Calcareous nannoplankton	Diatoms
1. Taxonomy	+ [a]	– [c]	+	–
2. General diversity	✓ [b]	+	–	✓
3. Diversity sufficiently high for polar Cenozoic paleoceanographic studies	✓	+	–	+
4. Diversity sufficiently high for subpolar Cenozoic paleoceanographic studies	+	+	+	+
5. Biostratigraphy known	+	+	+	✓
6. Biological controls known	✓	–	✓	+
7. Modern vertical and geographic distribution known	+	–	+	✓
8. Species and assemblage patterns match surface water masses	+	+	+	+
9. Morphologic variation related to environmental change	+	–	✓	–
10. Tests resistant to dissolution	–	+	✓	✓
11. Census data can provide data on original assemblages	✓	+	✓	✓
12. Tests resistant to lateral displacement (winnowing)	+	✓	–	–
13. Commonly found over wide areas in Cenozoic sediments	+	+	+	✓
14. Relative simplicity of counting	+	+	+	+
15. Tests suitable for isotopic measurements	+	–	+	✓

[a] + = relatively high values, or well known
[b] ✓ = moderately high values, or only partially known
[c] – = relatively low values, or poorly known

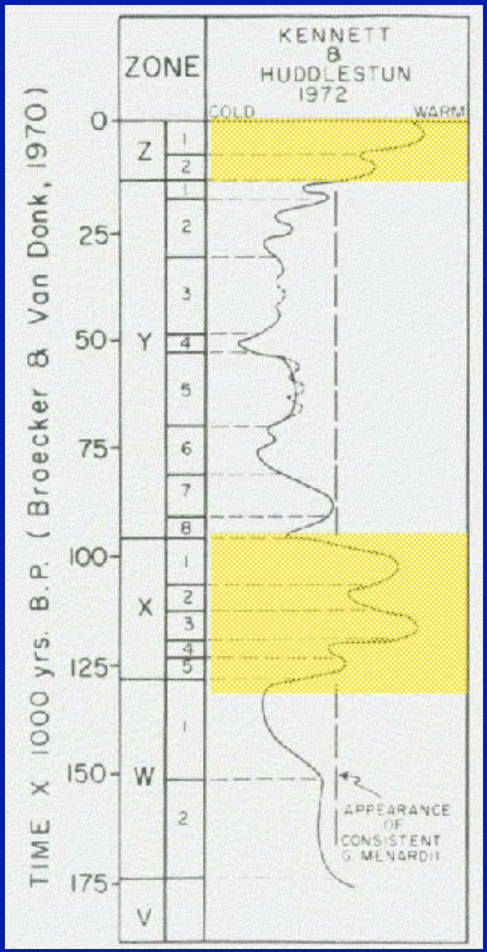
Comparison of characteristics of major microfossil groups used in marine geology work

Kennett (1982)

Planktonic Forams as Paleo-climate Proxies



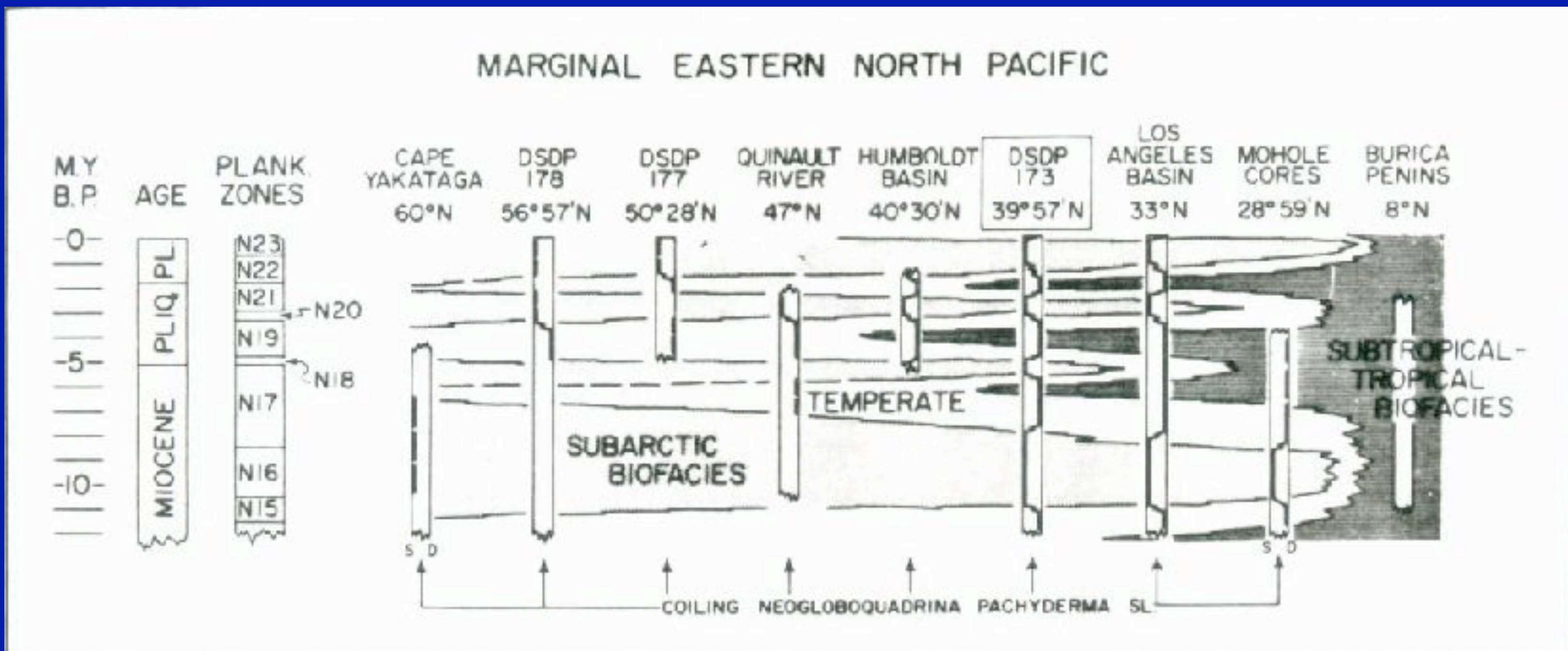
Major warm event in middle-Pliocene of California tracked by <u>G. inflata</u>



Kennett (1982)

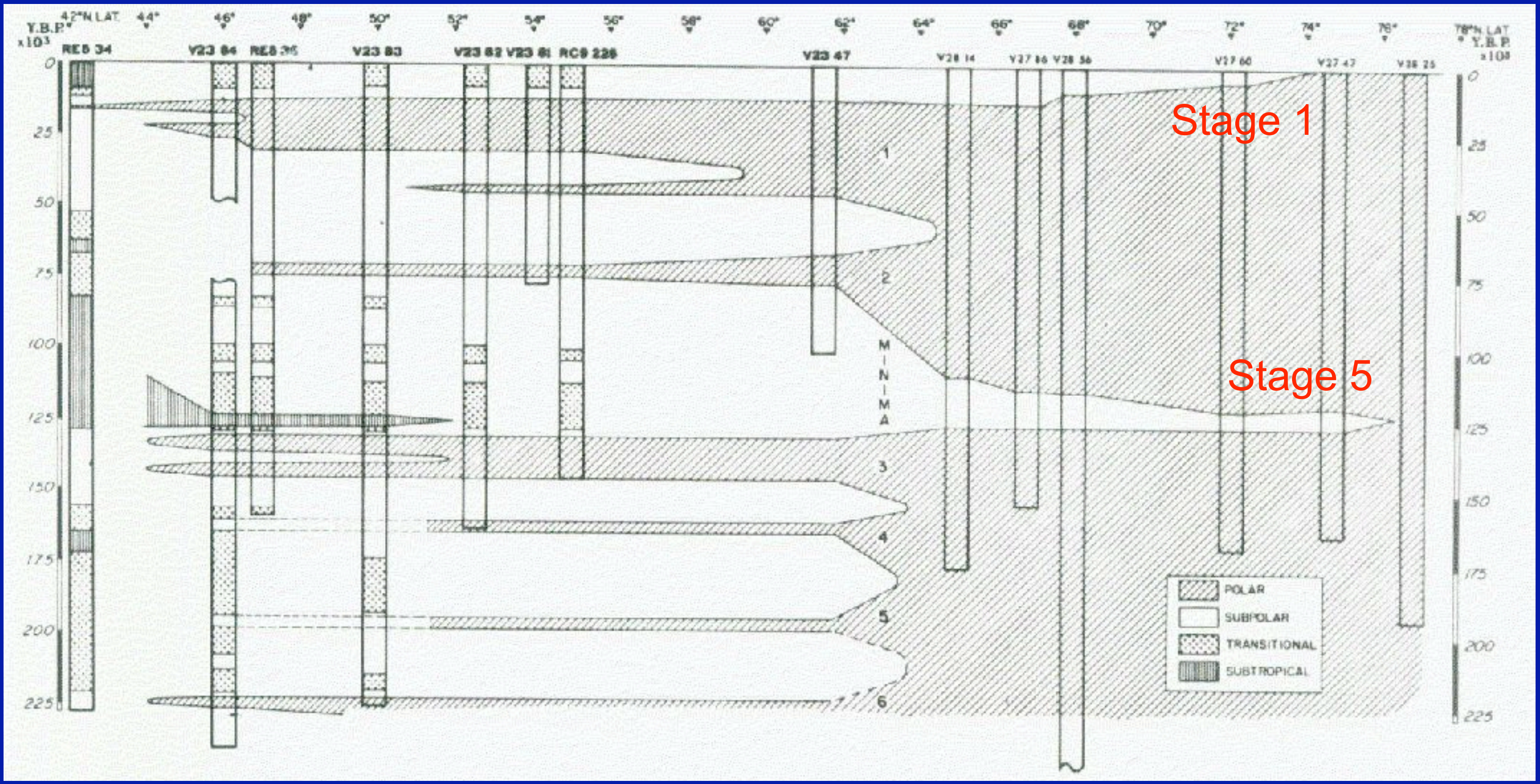
Late Pleistocene paleoclimatic curve from species frequency

Late Neogene Temperature Oscillations Revealed by Planktonic Forams



From: J. Ingle (1977)

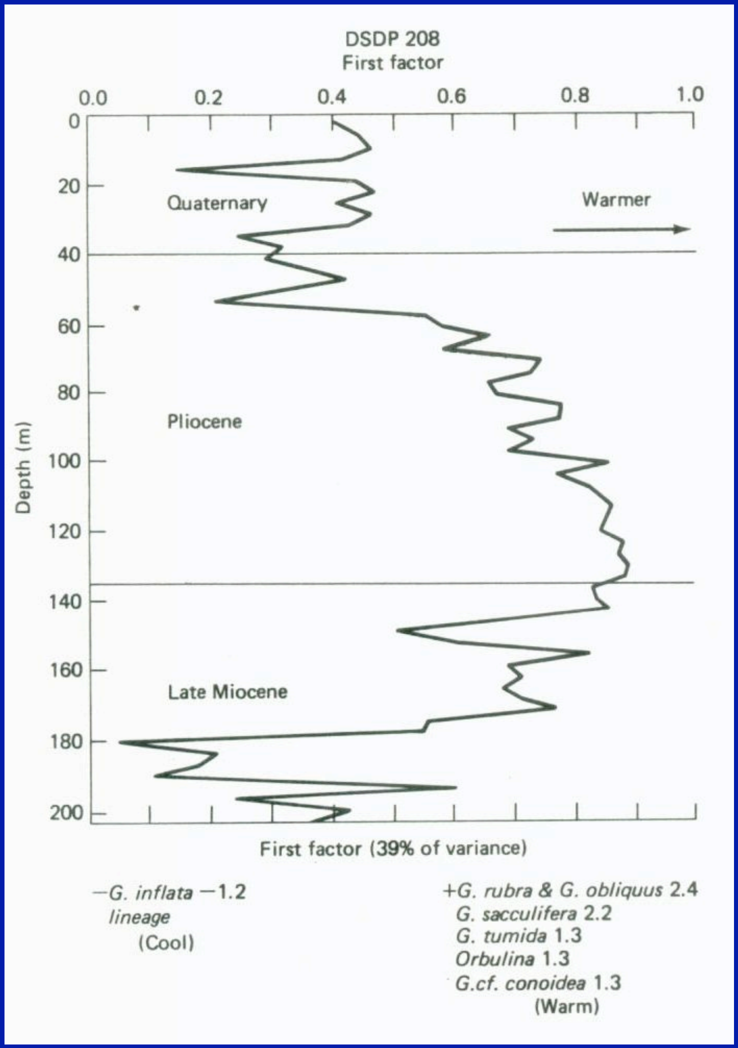
Late Quaternary, North Atlantic Paleoceanographic Oscillations



Based upon planktonic foraminiferal-coccolith assemblages specific to particular water masses.

From: Kellogg (1976)

Factor Analysis Time Series

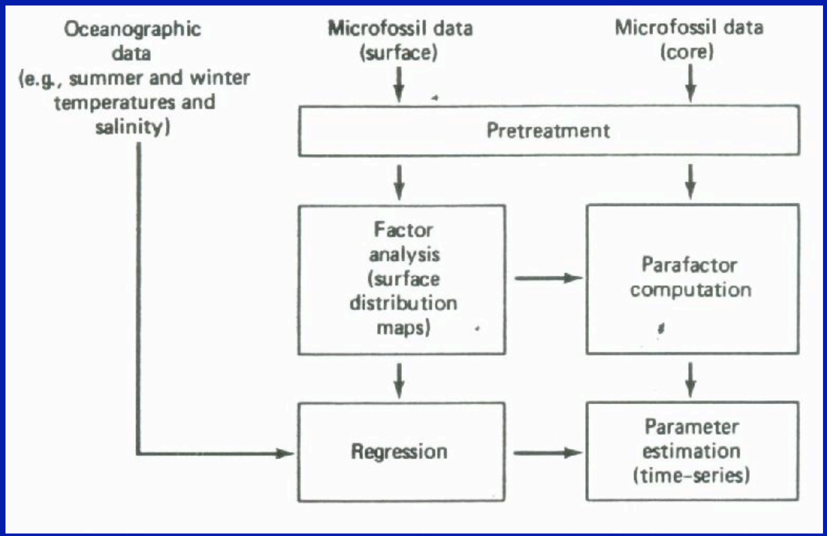


Factor analysis is a relatively unbiased, quantitative statistical approach to interpreting large, multivariate data sets ⇒ fewer, more interpretable variables (usually 3 to 4 at most)

Result (in this case) is quantitative measure of paleo-climate variations through time.

Numbers next to species refer to their loadings on Factor 1.

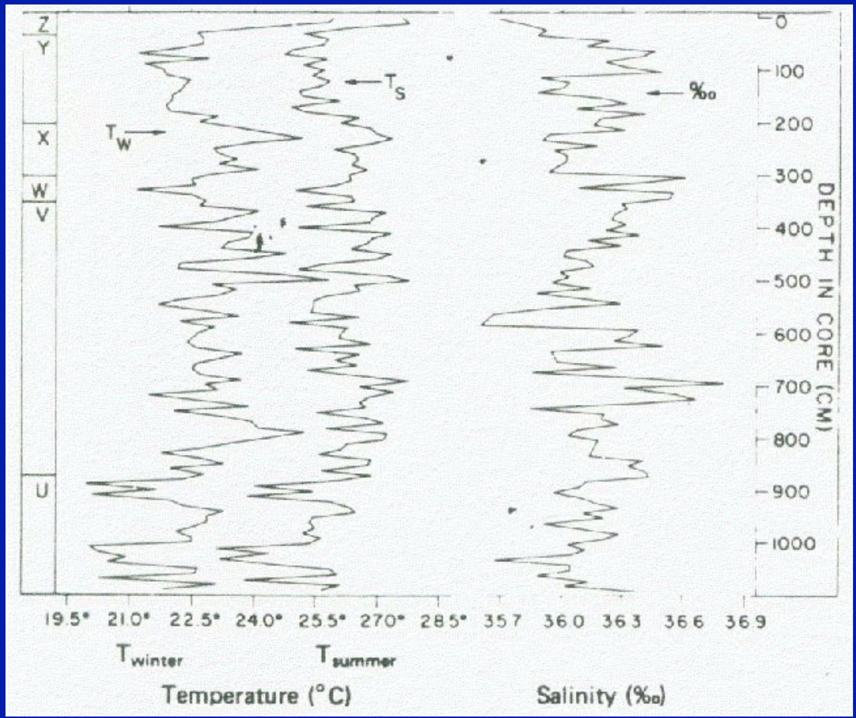
Factor Analysis Time Series



Process of estimating paleo-temperature & paleo-salinity using microfossil assemblage data and factor analysis.

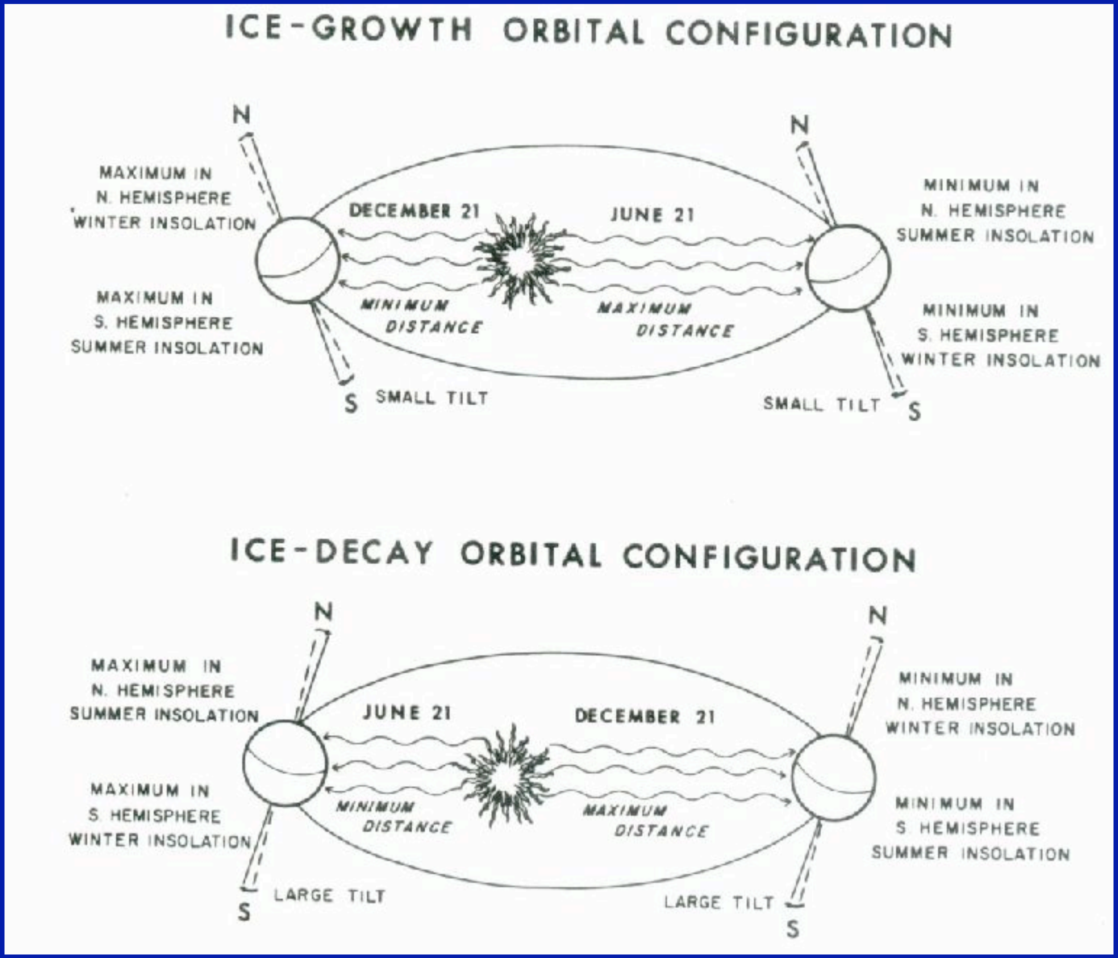
<u>Assumptions are made</u>: past is similar to the present; species evolution has negligible effect.

Kennett (1982)



Results: time-series of past summer & winter temperatures and salinity in a Caribbean core.

Underlying Causes of Pleistocene Climate Variations



HINT: Google “Milankovitch”