THE INTERPRETATION OF THE GEOCHEMICAL RECORDS DERIVED FROM MASSIVE CORALS NEED TO BE REVISITED

Anne Juillet-Leclerc (1)

THE CORAL TEAM: D. Allemand (2), D. Blamart (1), J.P. Cuif (3), T. Corrège (4), Y. Dauphin (3), A. Denis (3), C. Ferrier-Pagès (2), F. Le Cornec (5), S. Reynaud (2), C. Rollion-Bard (6)

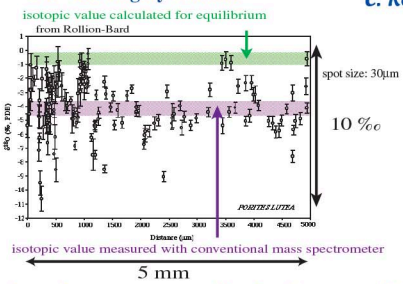
1 LSCE Domaine du CNRS, 91198 Gif sur Yvette, France
2 CSM Avenue Saint-Martin MC-98000 Monaco, Principality of Monaco
3 Laboratoire de biominéralisation, Bat 504, Université Paris XI, 91405 Orsay, France
4 IRD, BPA5, Nouméa, New Caledonia
5 CRPG, B.P. 20, 54 501 Vandoeuvre-lès-Nancy Cedex, France
6 IRD, 32 avenue Henri-Varagnat,93143 Bondy Cedex, France

Tropical ocean-atmosphere interaction plays a key-role for worldwide climate variability. Instrumental observations are available only for the last decades and paleoclimatic reconstruction becomes necessary to recognize decadal and longer changes of the tropical system. Long-live massive corals, developed all around tropical belt, are unique archives offering both annual resolution and multicentury record lenght needed for reconstructing seasonal to centennial variations of tropical surface ocean variations. However recent investigations revealed unexpected evidences.

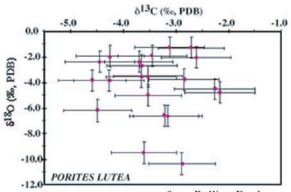
Evidences provided by SIMS measurements (Secondary Ion Mass Spectrometer)

C. Rollion-Bard, session BG2

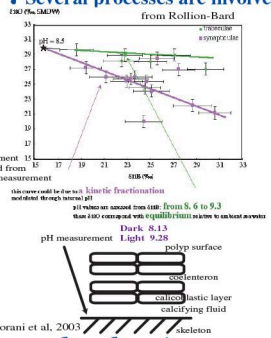
- $\delta^{18}O$ is highly variable



- At this scale, $\delta^{18}O$ and $\delta^{13}C$ are not coupled

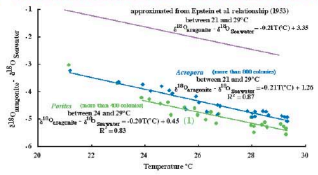


- Several processes are involved



At micrometer scale the isotope distribution in coral skeleton is much more complex than it was supposed

A "statistical" calibration



these are annual data from Weber and Woodhead (1972)
$\delta^{18}O_{Seawater}$ assessement from Juillet-Leclerc and Schmidt (2001)
each point derived from numerous colonies

The data obtained for *Porites* for the lower temperatures in Australia have been eliminated, because biologists emphasized growth properties which could affect isotopic values (Lough and Barnes, 2000).

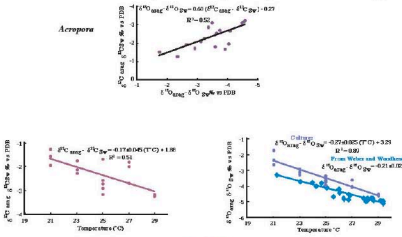
After removing biological variability $\delta^{18}O$ obeys to the isotopic thermometer

Evidences provided by cultures

Cultures are conducted under controlled conditions. Here, only temperature has been modified

S. Reynaud, session BG2

All the nubbins have been provided by a single mother colony, but $\delta^{18}O$ and $\delta^{13}C$ values exhibit a great variability



- $\delta^{13}C$ is temperature dependent
- $\delta^{18}O$ and $\delta^{13}C$ are correlated

a kinetic process is suspected but the SIMS measurements indicate that the processes which are responsible for each isotope are disconnected

- $\delta^{18}O$ isotopic fractionation is due to both:

a kinetic effect and the "isotopic thermometer"
the slope of the relationship obtained from the cultures is higher than that showed by "statistical calibration"

- C isotopic fractionation could be due to a kinetic effect

Measured $\delta^{18}O$ results of the addition of two fractionations

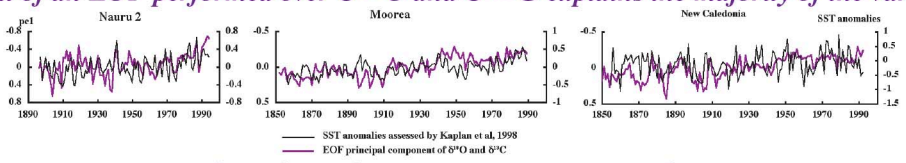
How to recognize the signal due to the kinetic process over long isotopic records?

- most of the isotopic series show a $\delta^{18}O$ and $\delta^{13}C$ correlation
- the principal component (PC) or empirical orthogonal function (EOF) analysis is used in order to find a time series that maximizes the covariance between the annual $\delta^{18}O$ and $\delta^{13}C$ covering at least 100 years

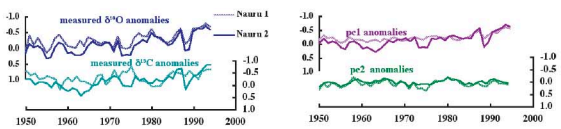
	Moorea	New Caledonia	Nauru 1	Nauru 2
	Boiseau et al. 1998	Quinn et al. 1993	Guilderson and Schrag, 1999	Guilderson and Schrag, 1999
lat-long	17°30'S-149°50'W	22°30'S-166°30'E	0.5°S-166°E	0.5°S-166°E
R (1)	0.62	0.53	0.79	0.82
% of variance (2)	0.81	0.78	0.89	0.91

(1) correlation coefficient of $\delta^{18}O$ and $\delta^{13}C$
(2) amount of isotopic record explained by the first component of the EOF

The principal component of an EOF performed over $\delta^{18}O$ and $\delta^{13}C$ explains the majority of the variance of the measurements.



The principal component is temperature dependent when SST variations are predominant over time.
The relationship is not linear
Elsewhere, it could be influenced by salinity (for example in the Fiji core (Le Bec et al, 2001))



- the sampling resolution is the same for the two cores only during the period comprised between 1952 and 1993

- each colony shows its own principal component:
pc1 signal is influenced by environmental parameters through biology

Pc1 is the background of the isotopic curves, due to a kinetic process.
It could be considered as "the vital effect" showed by each colony.