WHAT IS $\delta^{13}C$?

Carbon has two stable isotopes:

C-12 (^{12}C)

C-13 (^{13}C)

C-14 (^{14}C) is instable form.
Its half life (decay 50%) is 5730 years.

Not for geology.

These two are slightly different in mass

but have the same chemical properties.

The relative amounts of these two isotopes

vary in carbon-bearing material, and these

variations give useful geochemical information

WHAT IS $\delta^{13}C$?

$\delta^{13}C$ is used to show the relative abundances of ^{13}C and ^{12}C .

$\delta^{13}C$ is the ratio difference of ^{13}C to ^{12}C of the sample which is determined on an isotope-ratio-mass spectrometer

$\delta^{13}C$ is expressed in part per thousand or "per mil" (‰)

$$\delta^{13}C = \left[\frac{(^{13}C/^{12}C)_{sample}}{(^{13}C/^{12}C)_{standard}} - 1 \right] \times 1000$$

WHAT IS δ^{13}C?

The standard is a Belemnite carbonate from the Peedee Formation (PDB) in South Carolina, USA

Name	δ^{13}C
PDB	0.00 (standard)
Graphite, NBS Reference	-27.79
Ticino marble, Basel	2.77
Te Kuite limestone, New Zealand	-1.67
$BaCO_3$, Stockholm	-10.32

Value relative to PDB ‰

Interpretation of $\delta^{13}C\_CO_2$ Data

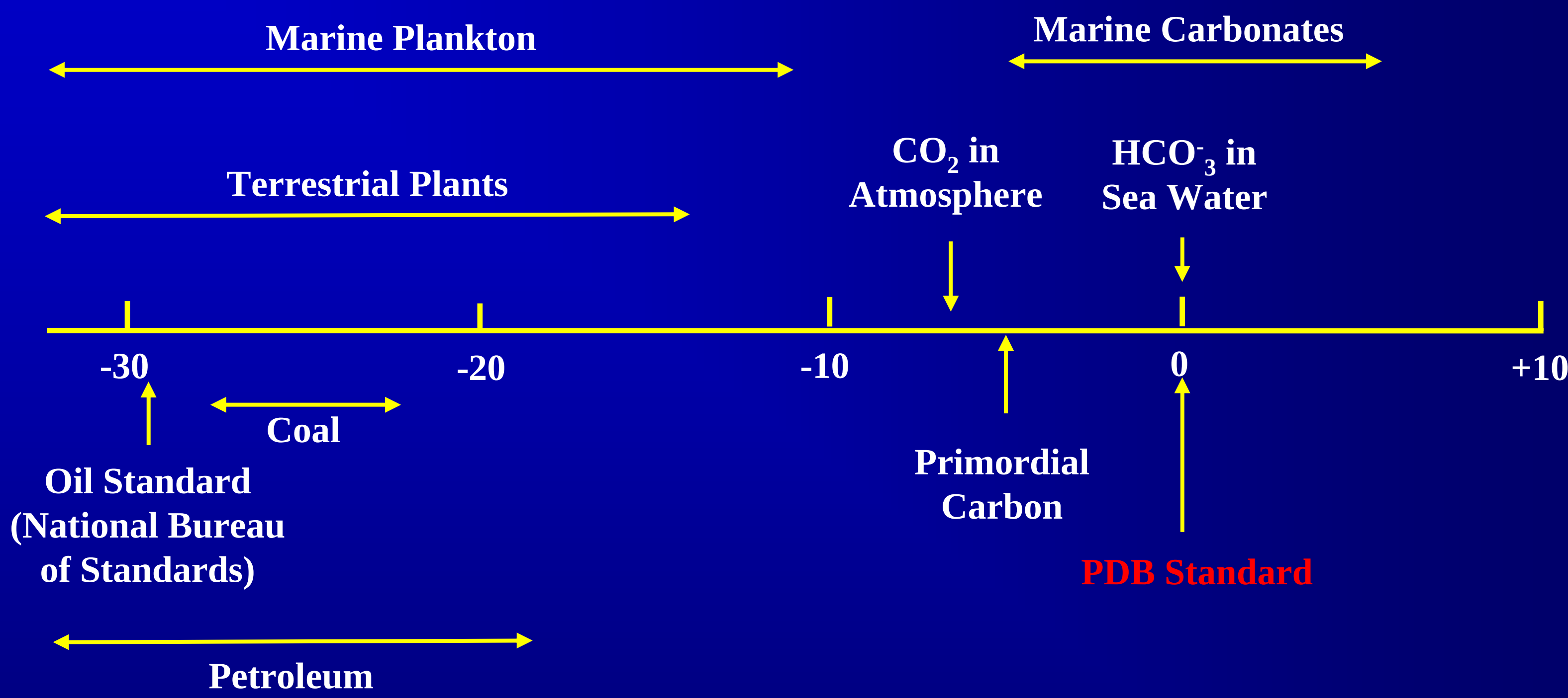
CO_2 in the atmosphere is richer in ^{12}C ("lighter") than CO_2 in seawater.

Thus the terrestrial plants tend to be richer in ^{12}C than marine plants (algae).

In aqueous phase, there is an isotopic equilibrium between carbon dioxide and bicarbonate. This reaction leads to change the isotopic ratios known as "fractionation".

Fractionation is complex and requires quantum mechanics

Interpretation of $\delta^{13}C\_CO_2$ Data



The range in the carbon –13 content of carbon reservoirs

(unit in part per thousand relative to the Peedee belemnite standard)

(modified from Hunt, 1996)

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Interpretation of $\delta^{13}C\_CO_2$ Data

General Rules of isotopic fractionation:

(1) The lower molecular wt compound is enriched in the lighter isotope.

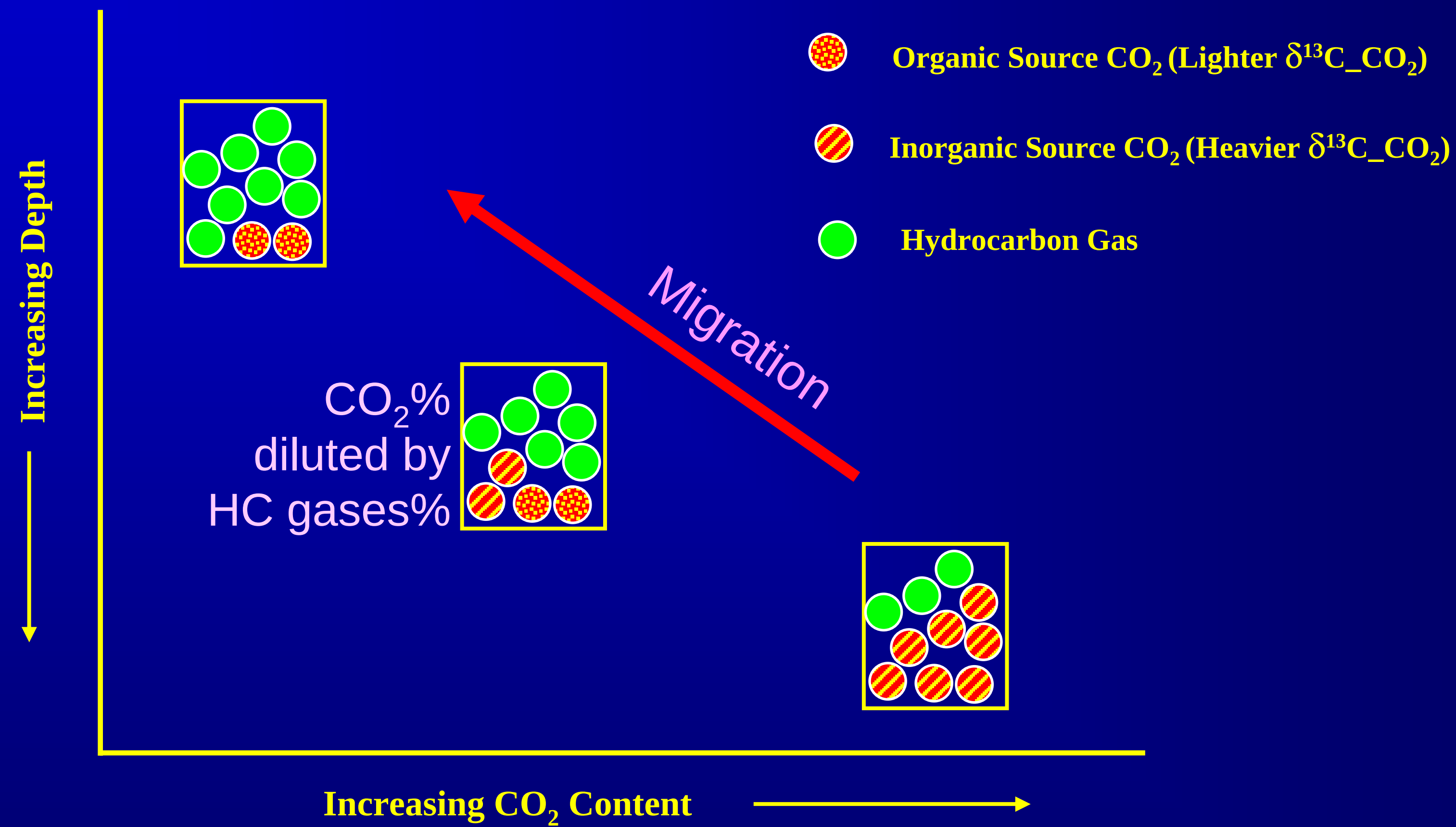
(2) Reduced carbon compounds tend to be lighter than oxides carbon compounds

(3) The amount of fractionation decreases with increasing temperature

For example, in the equilibrium reaction,
CO_2 (molecular wt 44) is enriched in C^{12}
relative to HCO_3^- (molecular wt 61)....

but the enrichment decreases as T increases.

Interpretation of $\delta^{13}C\_CO_2$ Data



The schematic illustration of generalized distribution of CO_2 in the Gulf of Thailand

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