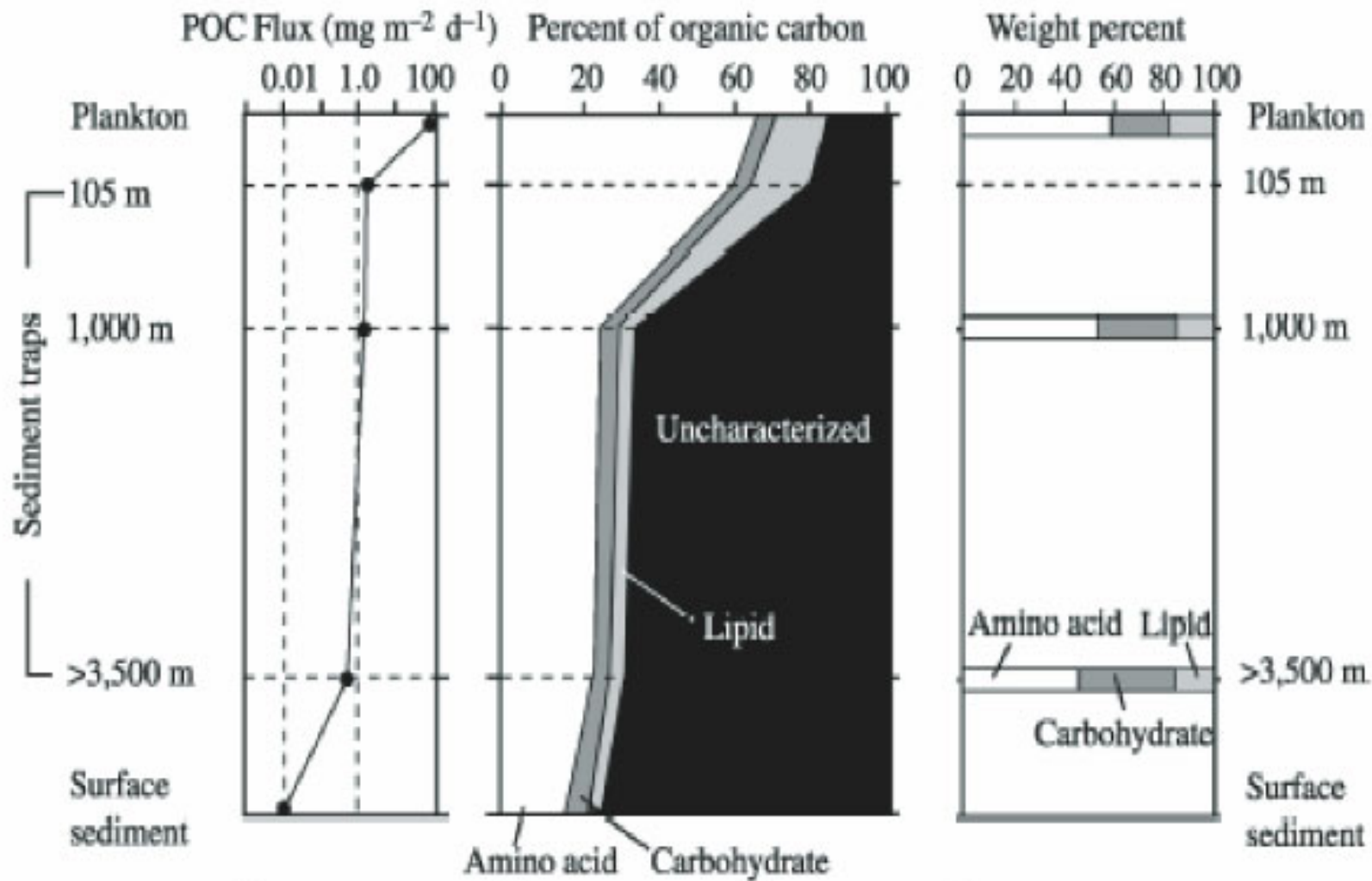


The composition of organic matter in marine sediments and the mechanisms of carbon preservation

- 1) Geopolymer model: Simple biomolecules (sugars, amino acids, lipids) recombine through unknown reactions to form complex substances that are not easy to degrade.
- 2) Selective preservation: Some compounds are intrinsically more labile than others, and will be preserved in sediments.
- 3) Physical protection/encapsulation: Organic matter can be “locked up”
In clay minerals, cysts, etc and preserved.

How can we test different models to determine which are important?

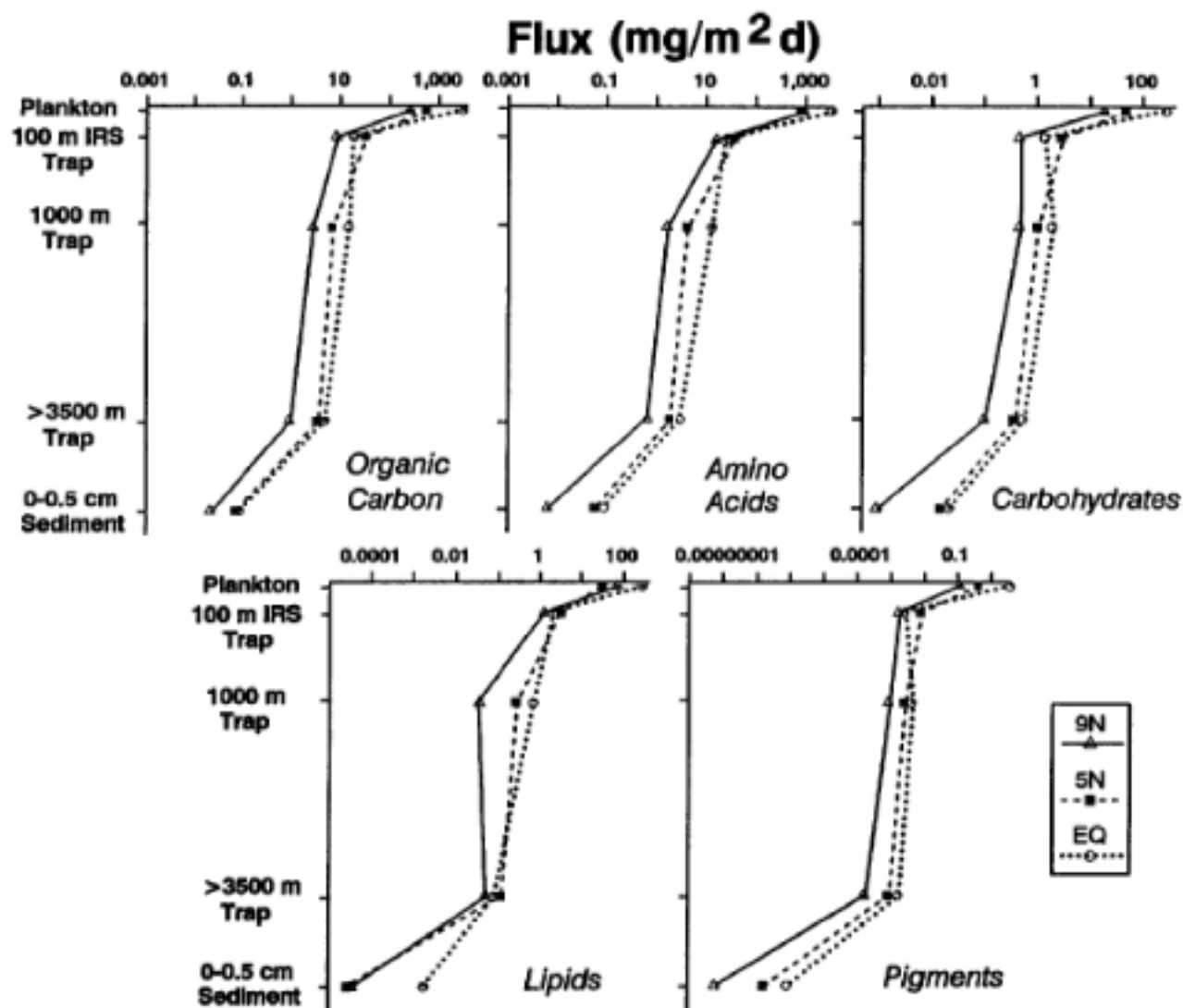


Eglinton & Repeta (2004) *Treatise on Geochemistry* 6 145-180.

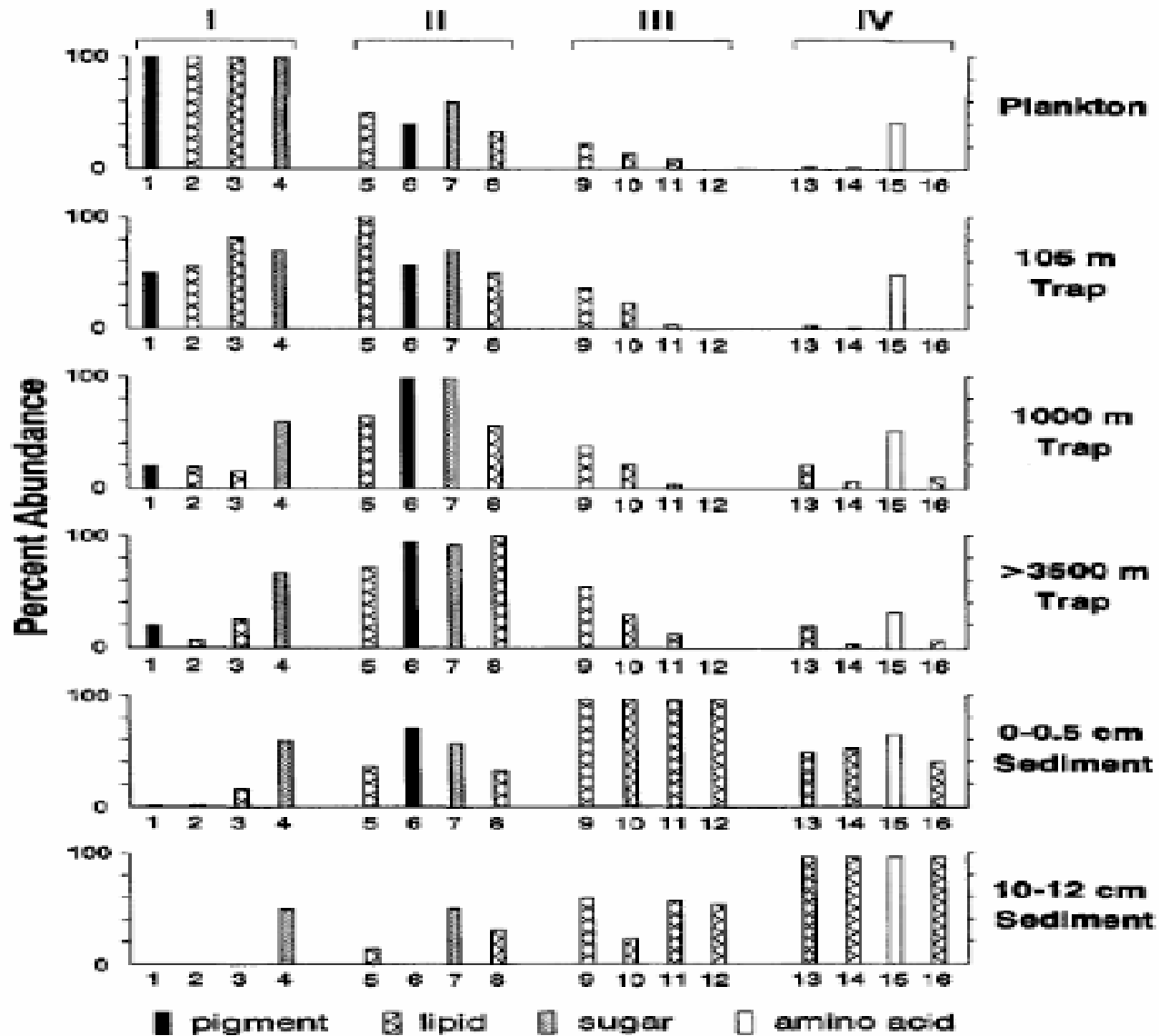
Selective preservation of OM as determined by the Molecular-level characterization of POM in sediment traps

Molecular indicators of diagenetic status in marine organic matter

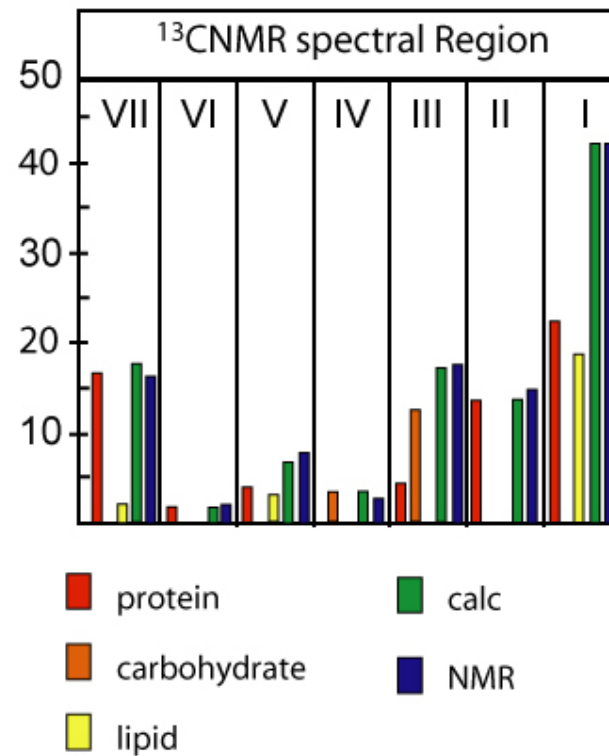
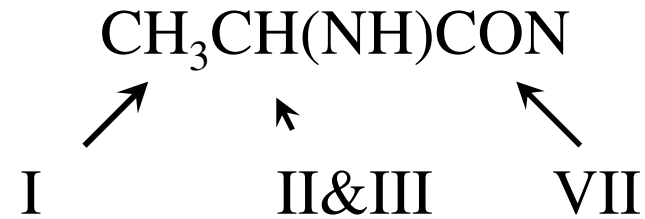
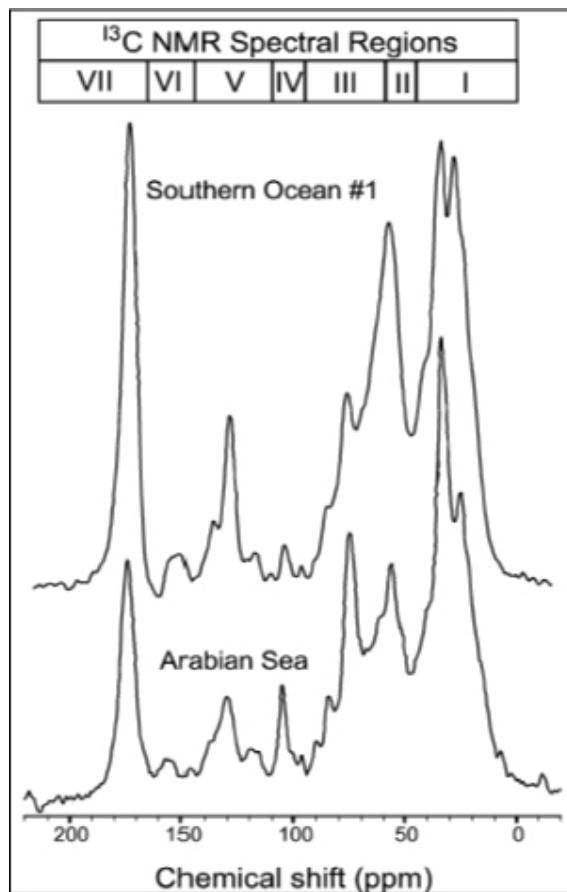
5365



Selective preservation of OM as determined by the Molecular-level characterization of POM in sediment traps

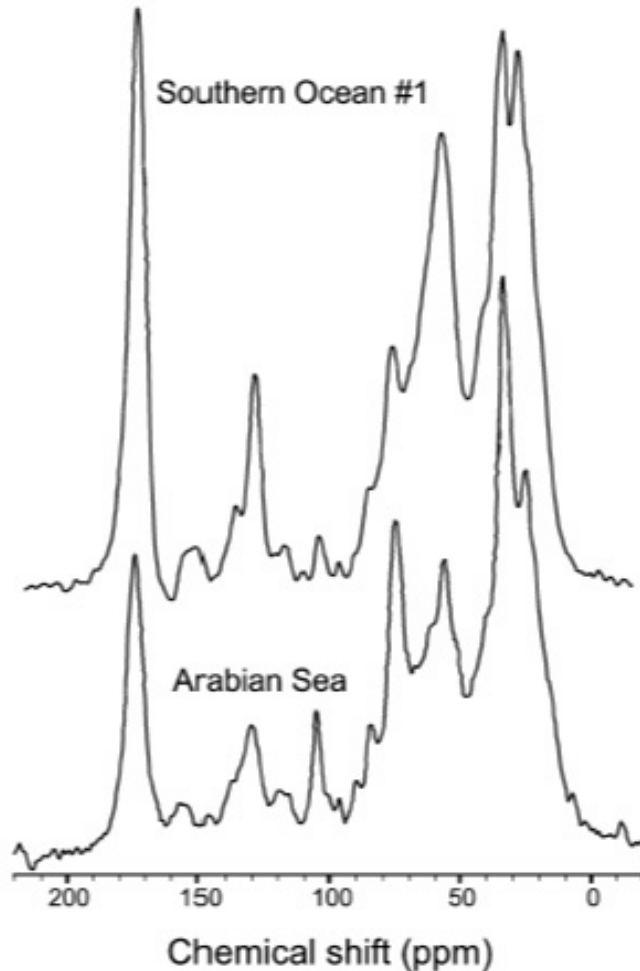


How well do we know the composition of marine algae?

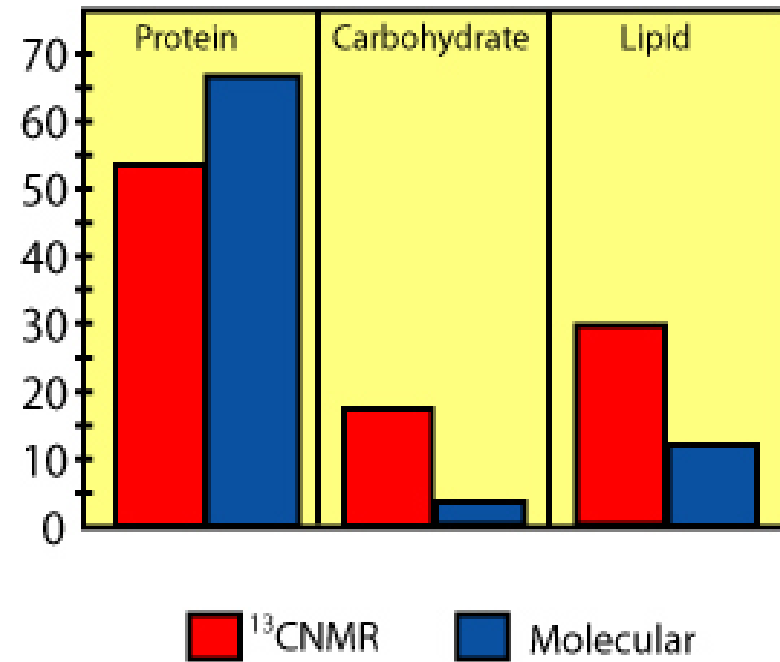


How well do we know the composition of marine algae?

¹³ C NMR Spectral Regions						
VII	VI	V	IV	III	II	I



Molecular analyses are unable to account for the NMR distributions of functional groups



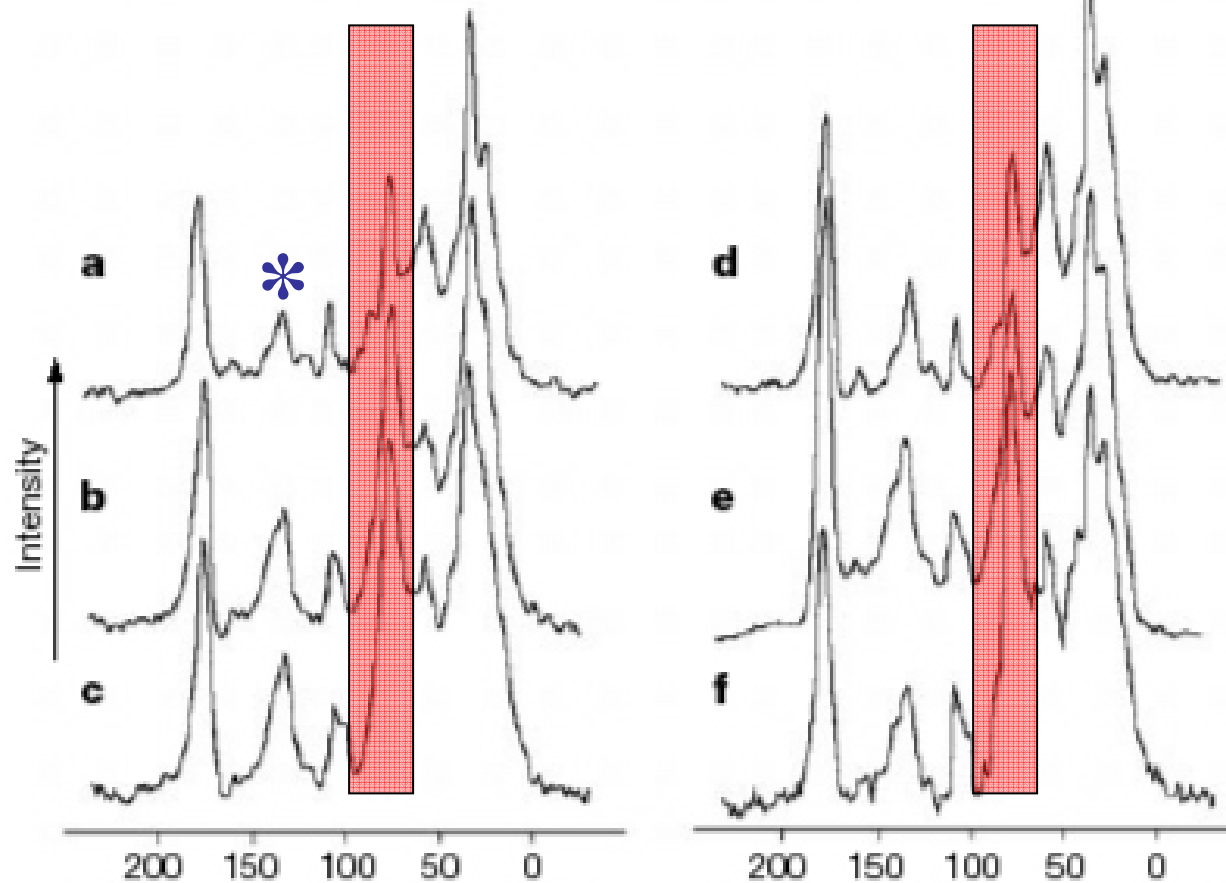
Does protein/carbohydrates/lipids account for Most of the C&N in algae?

Are the functional group assignments correct?

^{13}C NMR of phytoplankton, shallow and deep sediment trap material

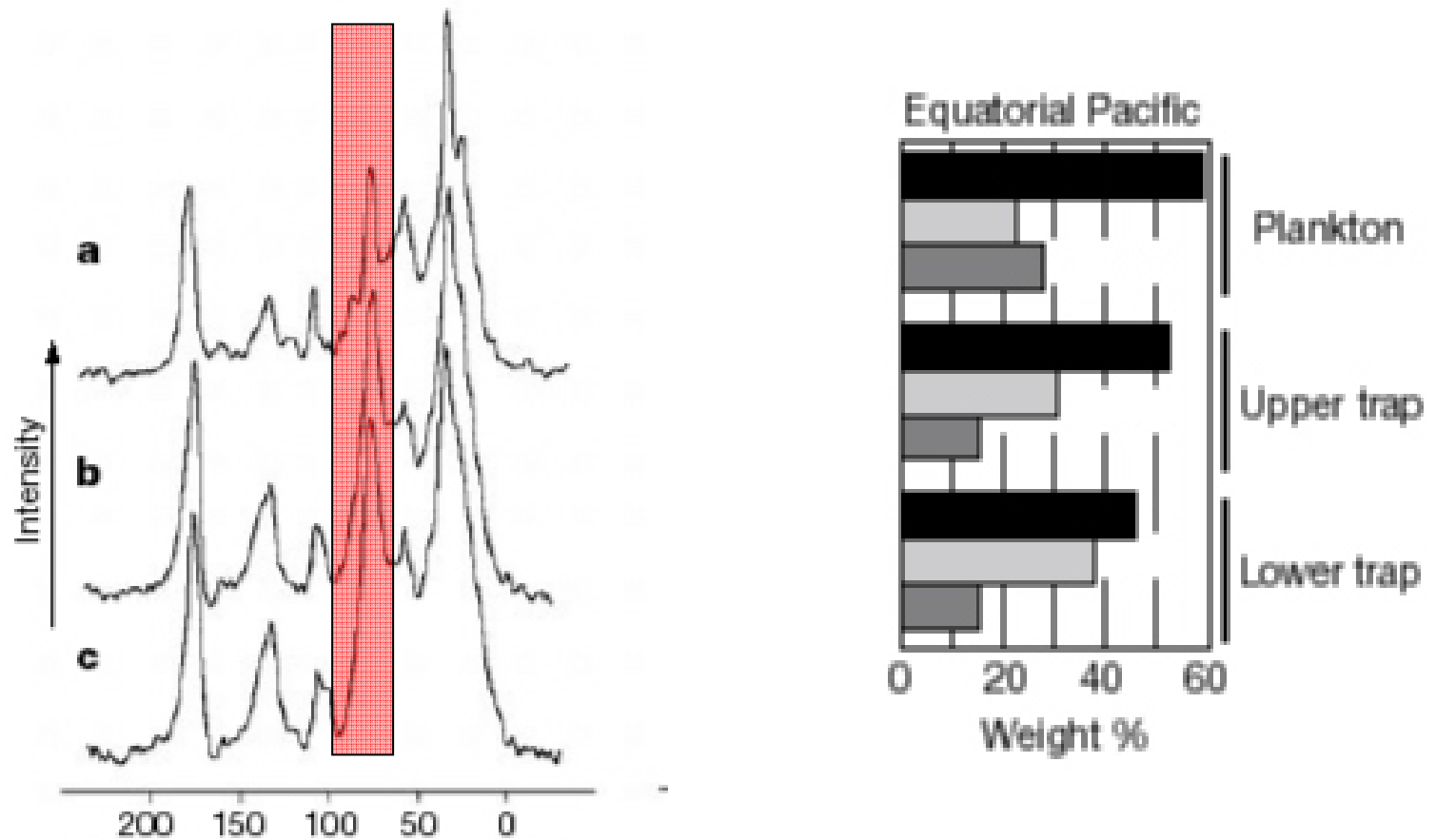
Pacific

Arabian Sea



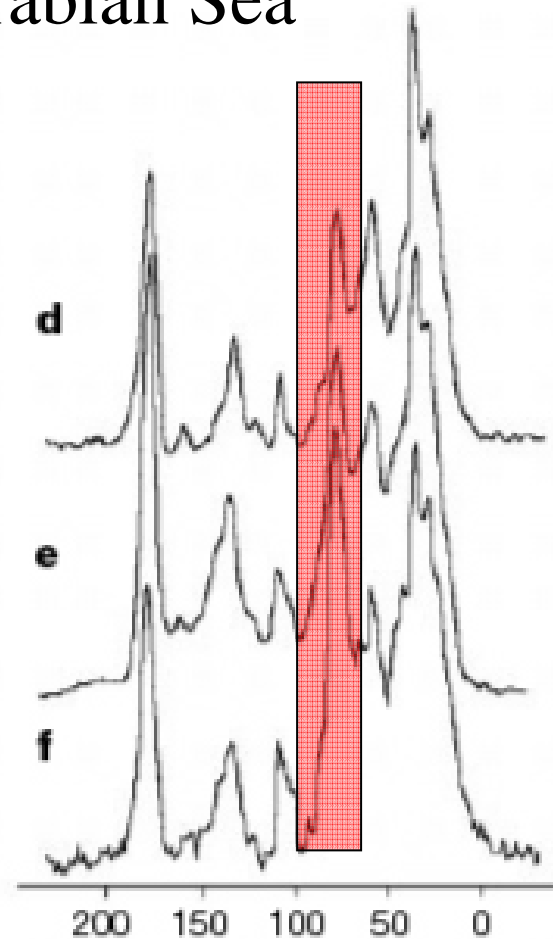
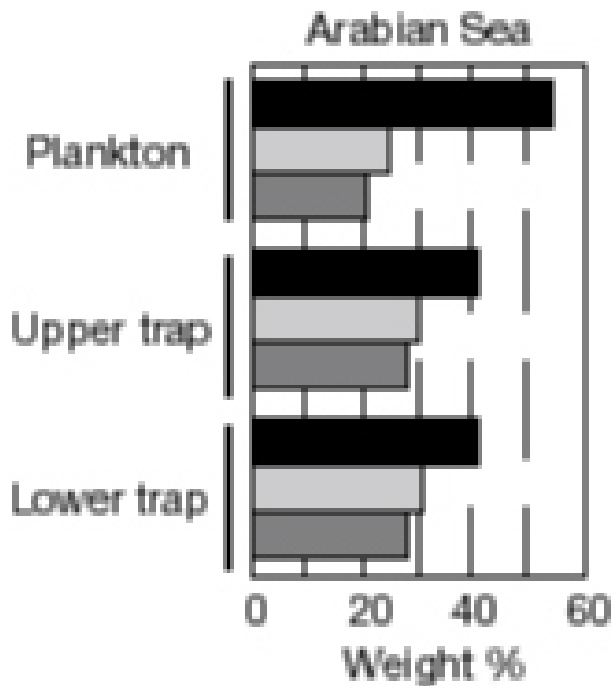
^{13}C NMR of phytoplankton, shallow and deep sediment trap material

Pacific

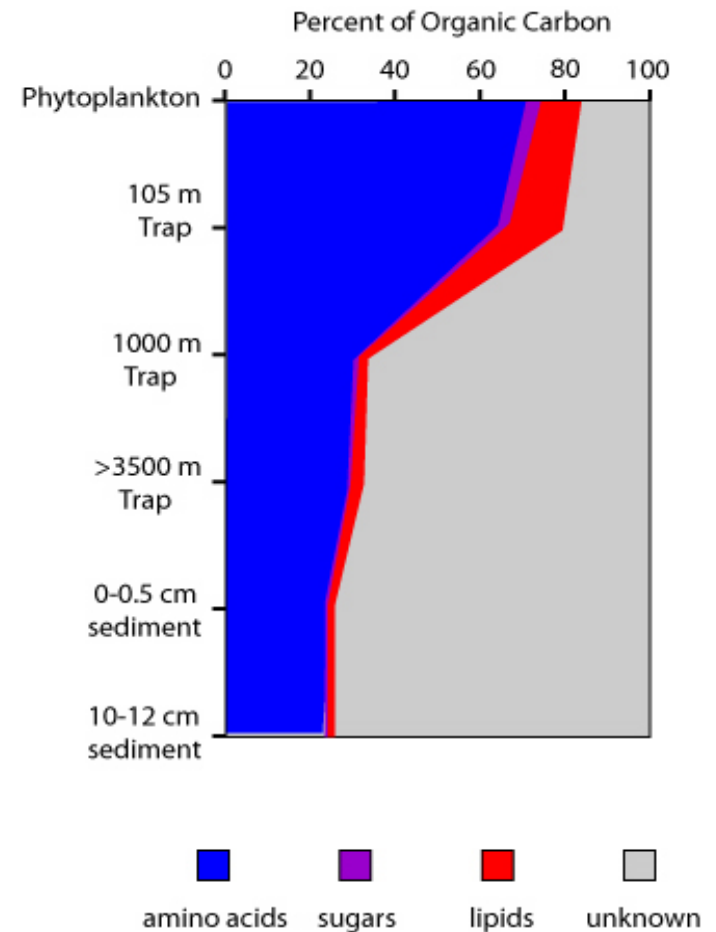
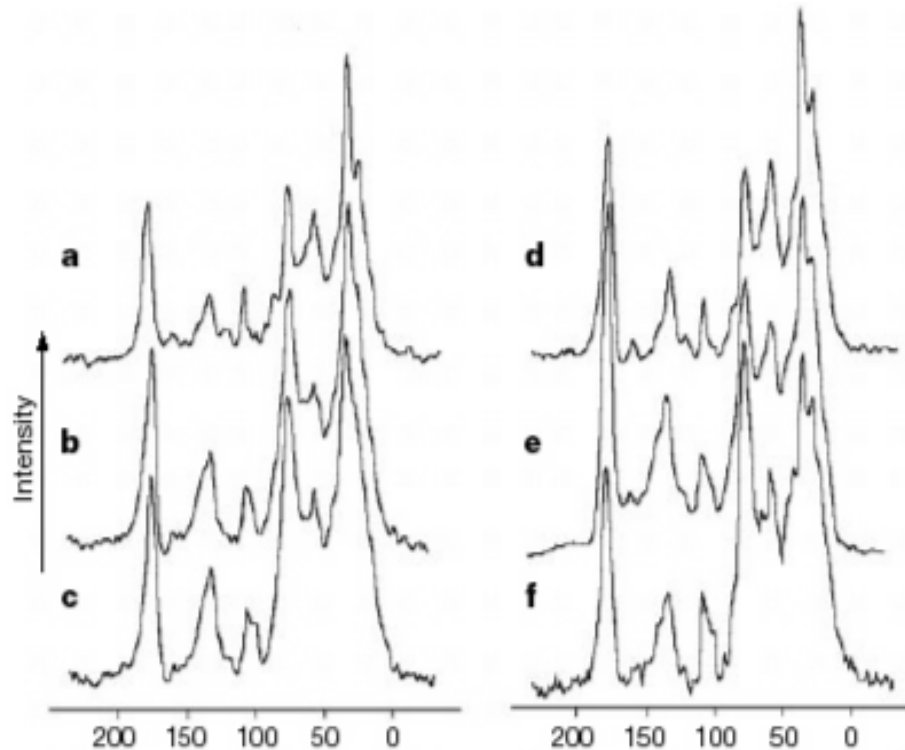


^{13}C NMR of phytoplankton, shallow and deep sediment trap material

Arabian Sea

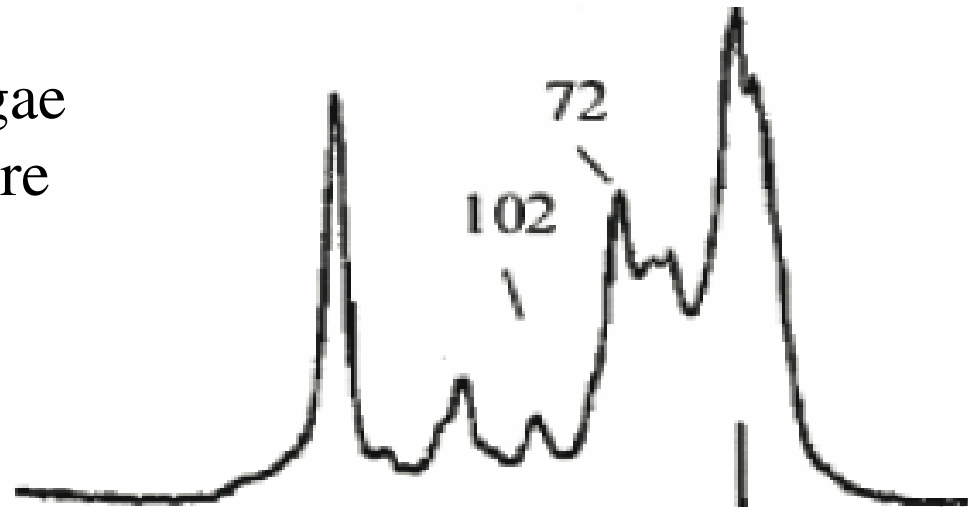


From the small changes in the ^{13}C NMR spectra of sinking POM, Hedges et al. infer that the C degradation acts non-selectively, and that preservation occurs via physical protection.

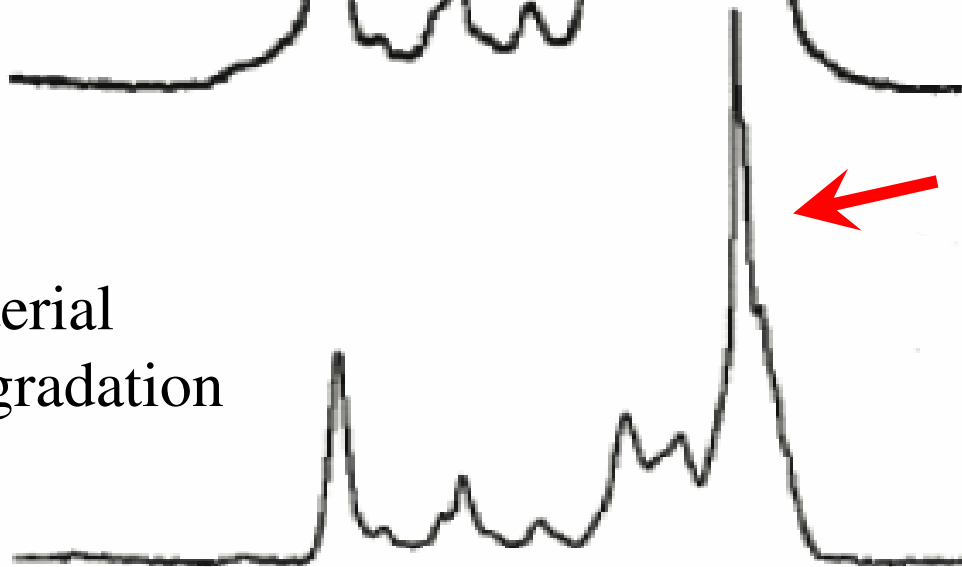


Physical entrapment into resistant geopolymers

^{13}C NMR of mixed algae
From laboratory culture



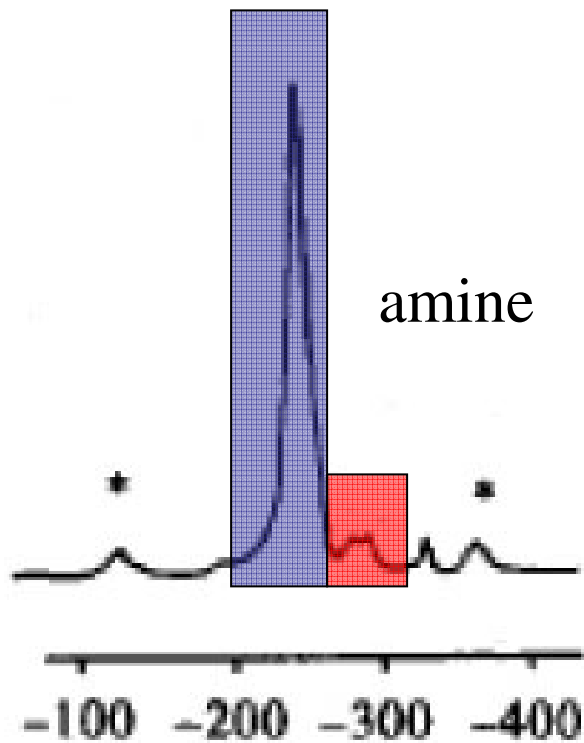
The same culture material
After 2 months of degradation



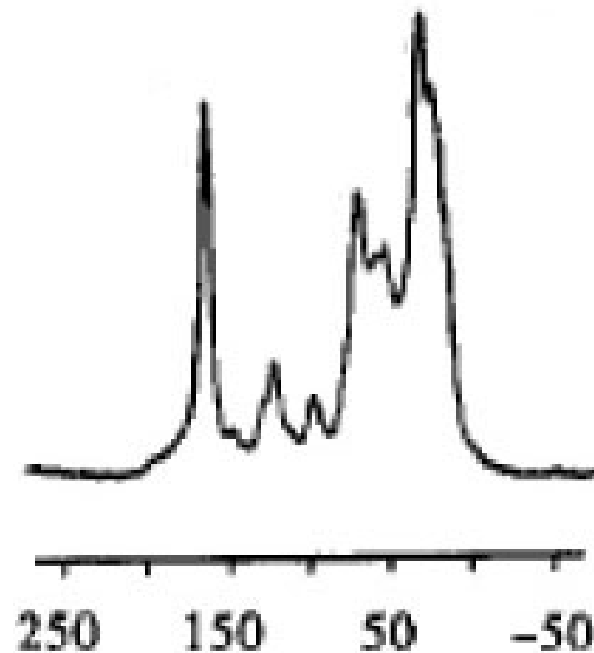
NMR spectra of fresh algae. ^{15}N and ^{13}C NMR show a large fraction of the material is protein, (amide, CON, CHO & CH_x)

Knicker et al *Org Geo* **24**, 661-669

^{15}N -NMR
amide

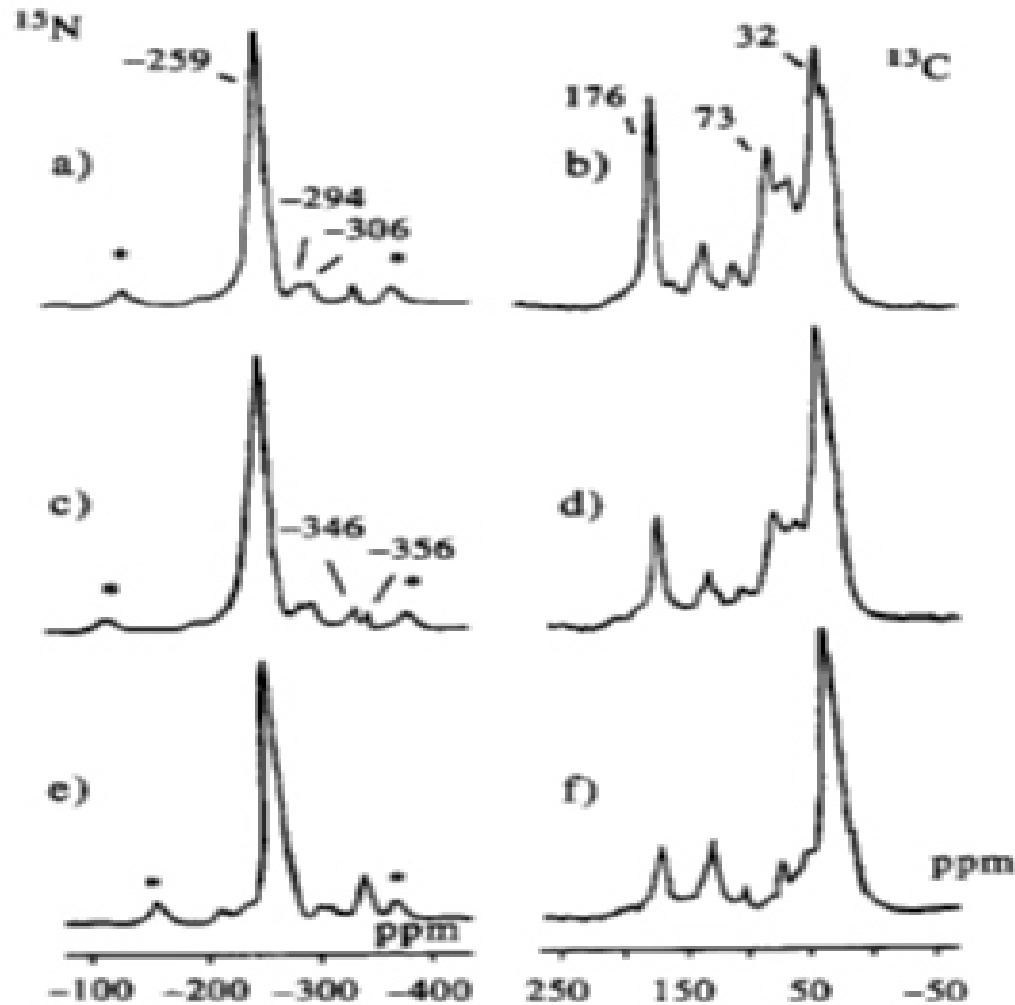


^{13}C NMR



^{15}N - and ^{13}C NMR study of algal degradation

Knicker et al *Org Geo* 24, 661-669



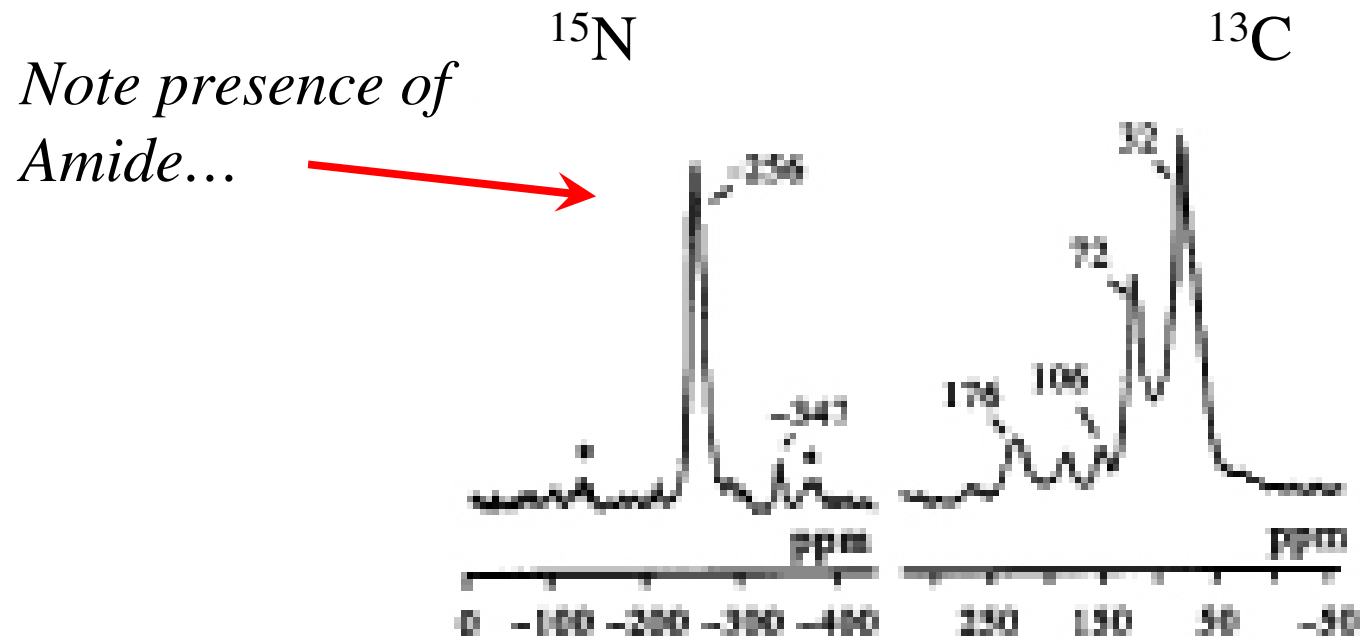
Fresh algae

Algal compost (60 d)

Algaenan
(nonextractable POM)

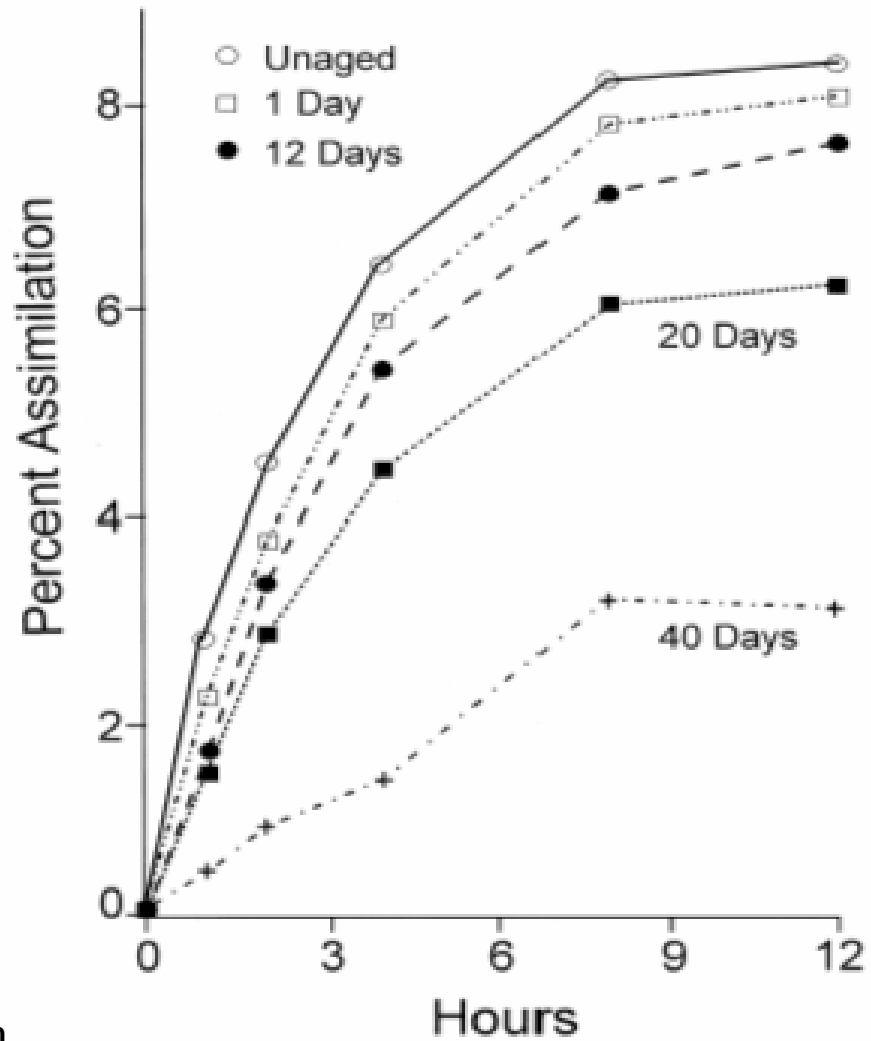
^{15}N and ^{13}C NMR of an algal 4000 yr old sapropel from Mangrove Lake, Bermuda

Knicker et al *Org Geo* **24**, 661-669



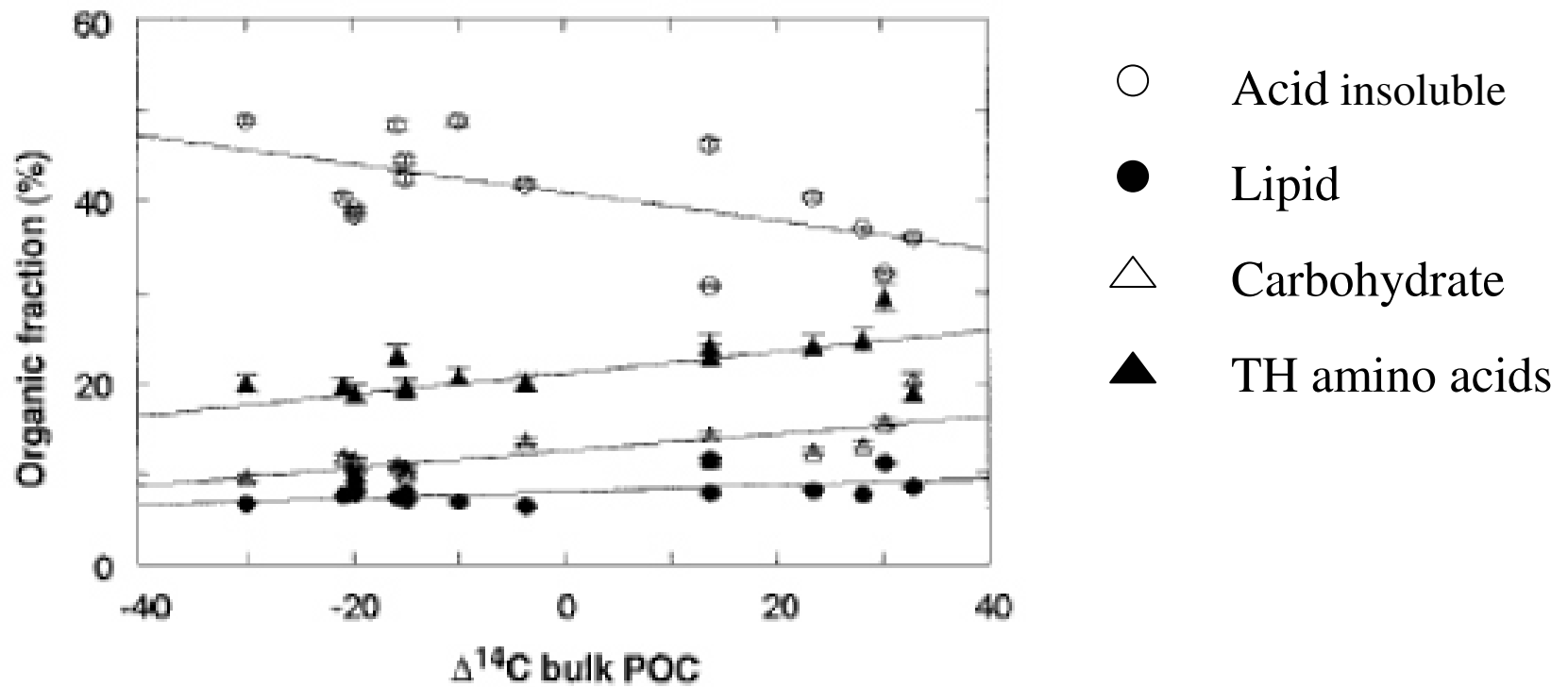
Knicker reasons that amide comes from protein, which should be labile. Preservation suggests some form of physical protection

but is protein labile?
The effect of aging on protein degradation



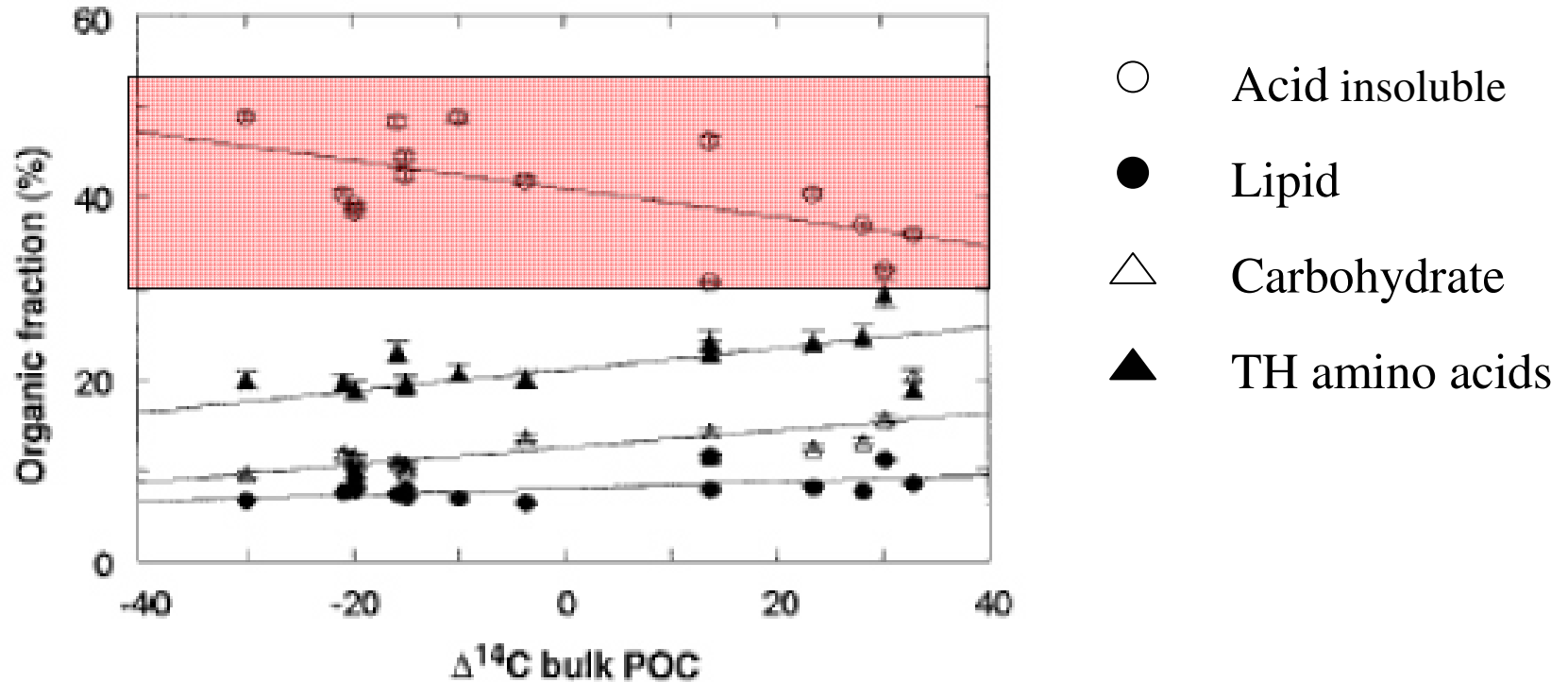
Keil and Kirchman

Another way to think about selective preservation....
What are the isotopic consequences of degradation?



J. Hwang & E.R.M. Druffel (2003) *Science*, **299** 881-884

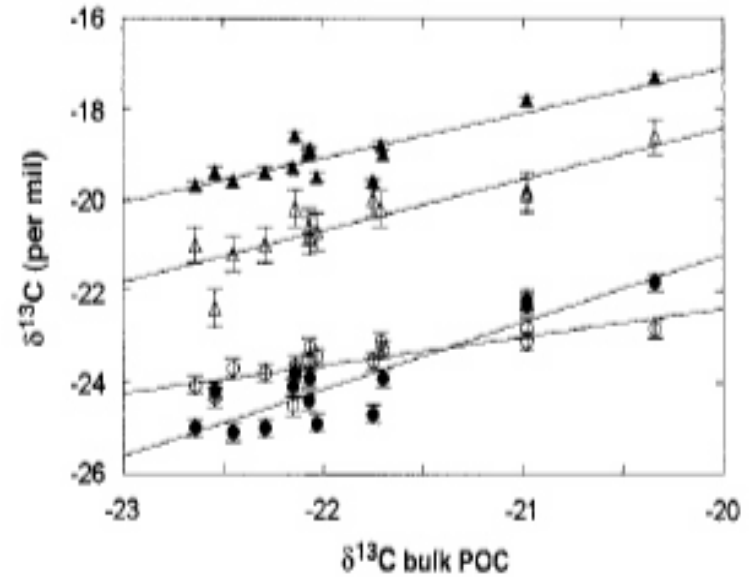
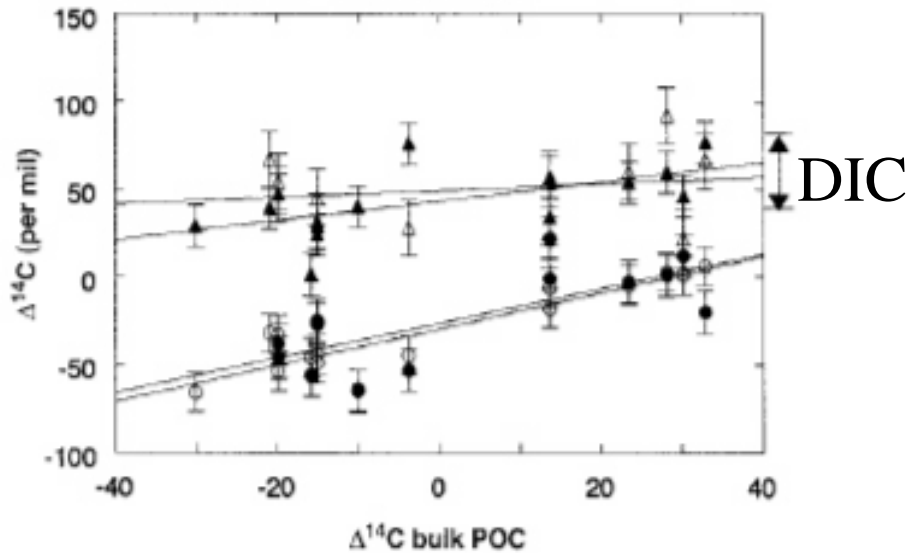
Another way to think about selective preservation....
What are the isotopic consequences of degradation?



As organic matter ages (^{14}C) the amount of acid insoluble C increases.....

J. Hwang & E.R.M. Druffel (2003) *Science*, **299** 881-884

And the C isotope ratios of the acid insoluble fraction looks a lot like lipids....



- Acid insoluble
- Lipid
- △ Carbohydrate
- ▲ TH amino acids

Summary.....

There is clear evidence for selective degradation of labile Organic matter in sinking particles and in fresh vs preserved OM

Selective preservation is quantitatively significant as it affects C/N ratios.

It is not clear if organic matter is protected by adsorption onto mineral surfaces.

Some organic matter is encapsulated into minerals and is protected, But this may or may not be quantitatively significant (globally)

Other means of physical protection have been proposed, but are a matter of conjecture (in my opinion)