From the top: surface-derived carbon fuels greenhouse gas production at depth in a peatland

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What is Peat?

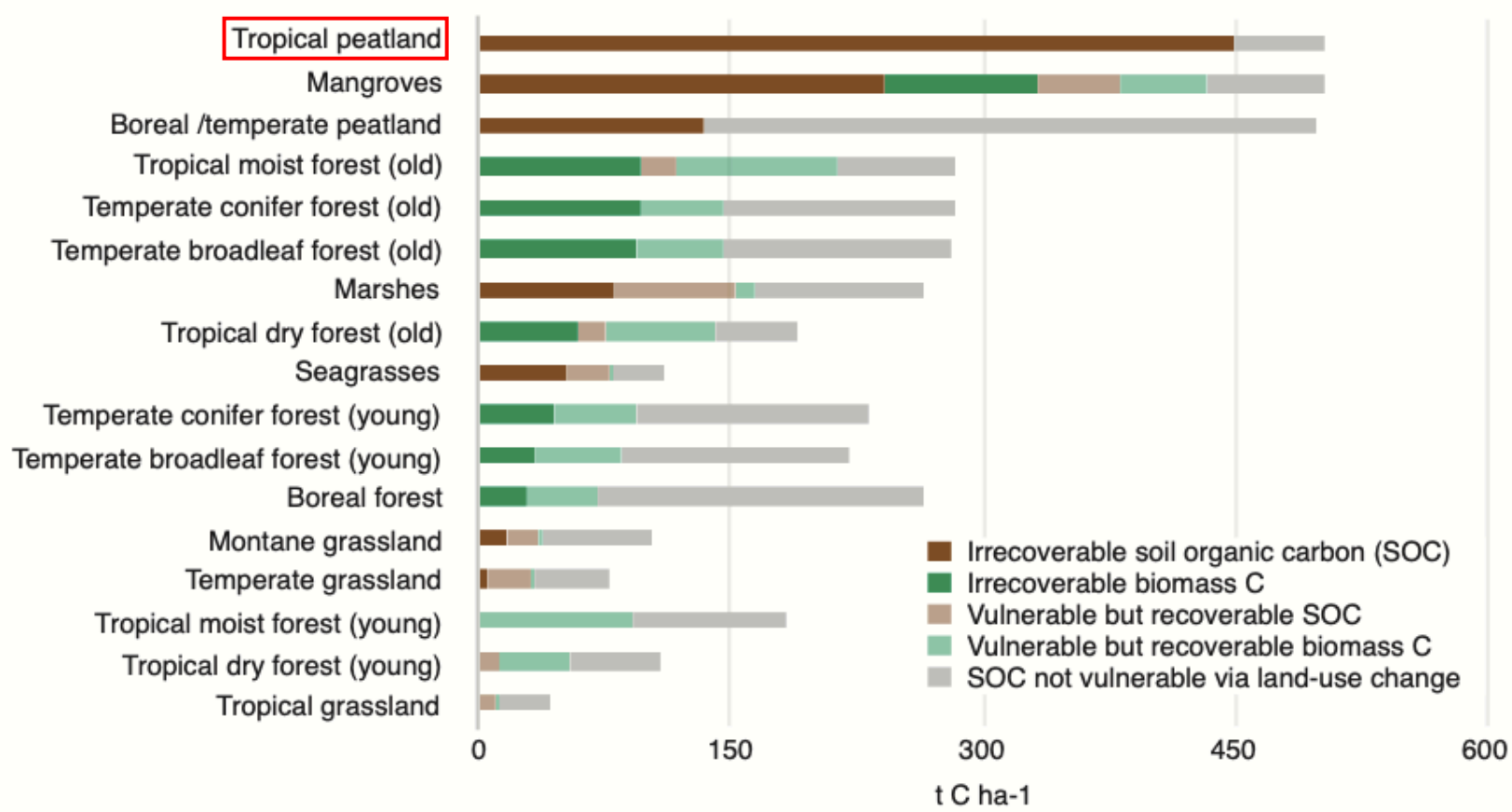
- Highly organic soil that has accumulated over thousands of years
- Environmental conditions cause an imbalance between inputs and decomposition
- The largest natural source of methane
- 40-60% Carbon
- Global Peatlands = 1/3 of total carbon in soils

Peatlands are important because they store and release carbon

https://blogs.egu.eu/geolog/2020/01/10/the-carbon-potential-of-peat/

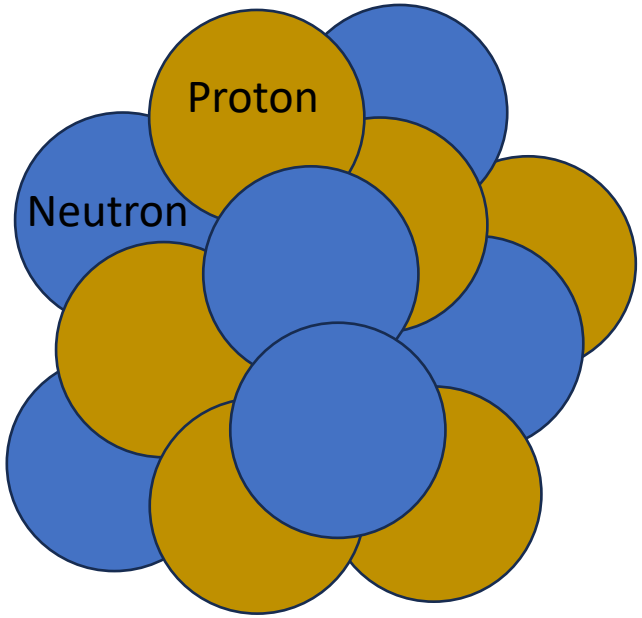
https://link.springer.com/chapter/10.1007/978-3-319-75527-4_7

Tropical peatlands contain the highest amount of irrecoverable C, and take the longest time to recover after C loss



Goldstine et al., 2020

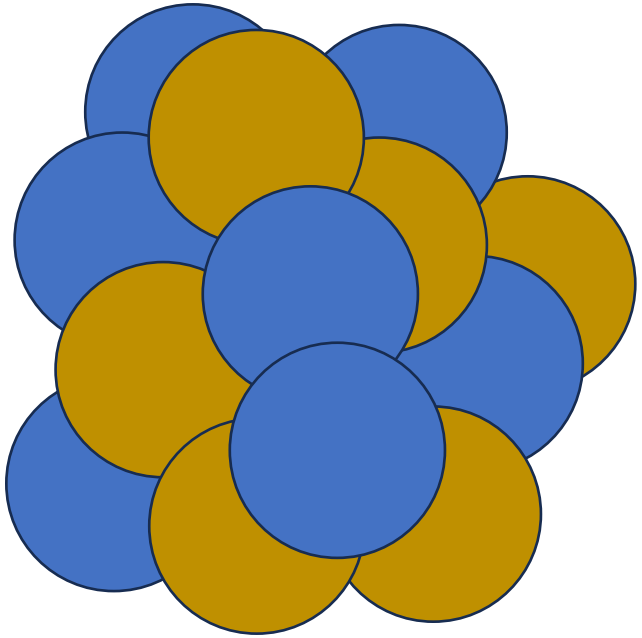
What's an isotope and why are they useful?



Carbon-12

Is the most common

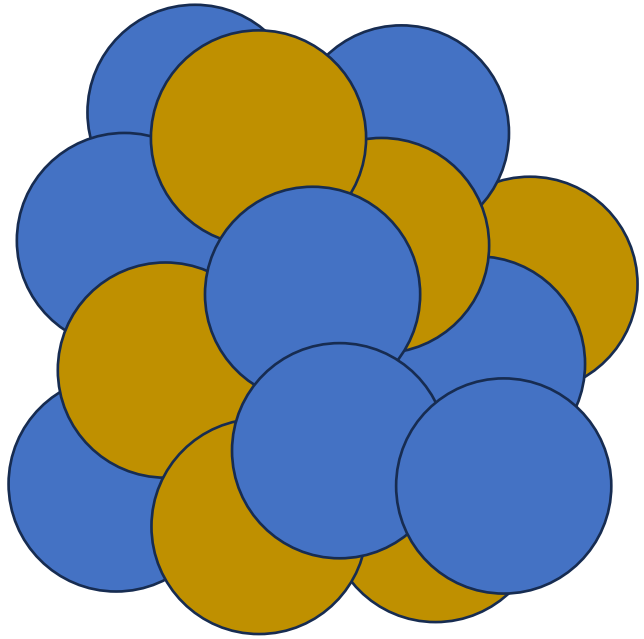
Stable



Carbon-13

Common

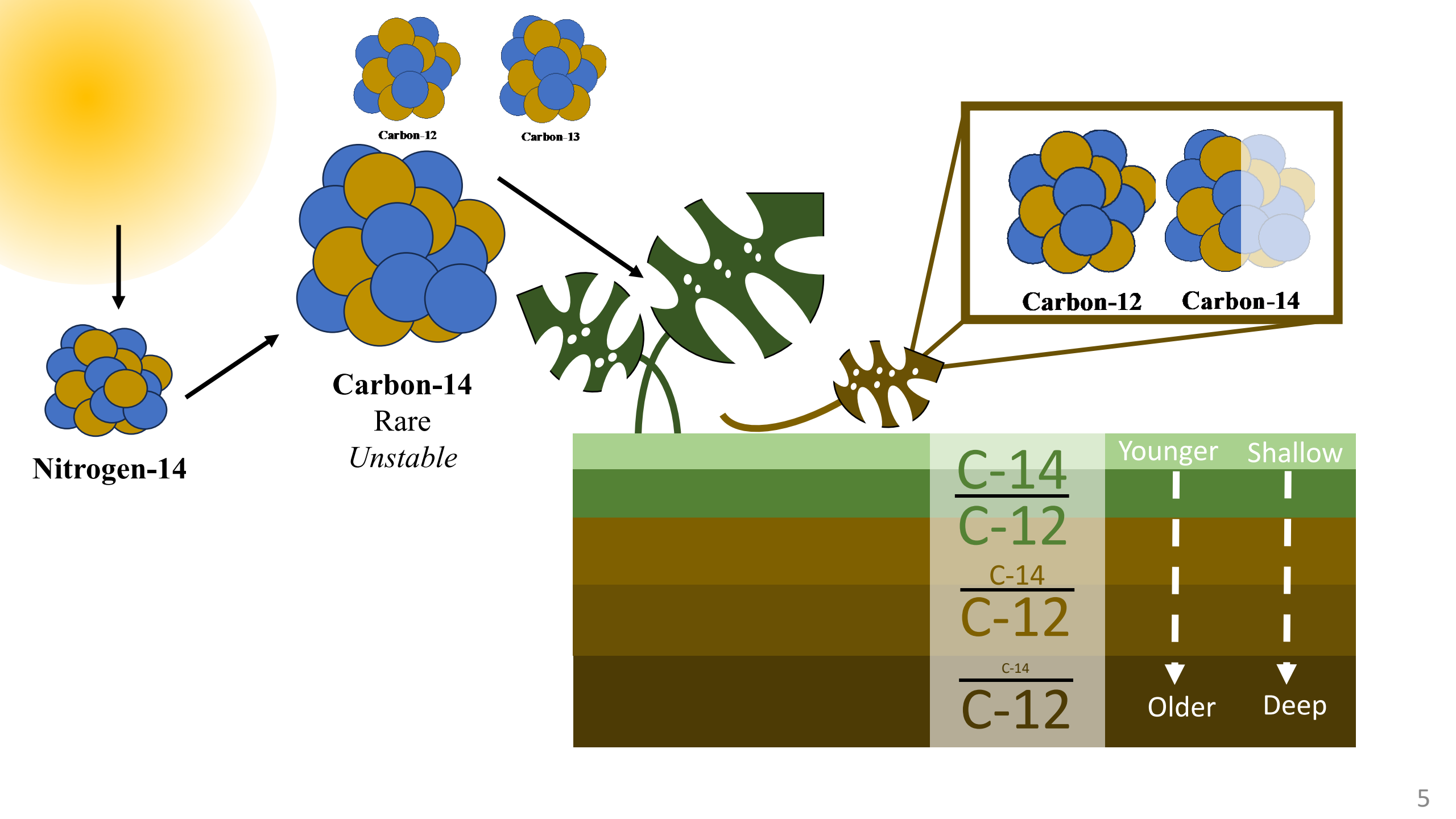
Stable

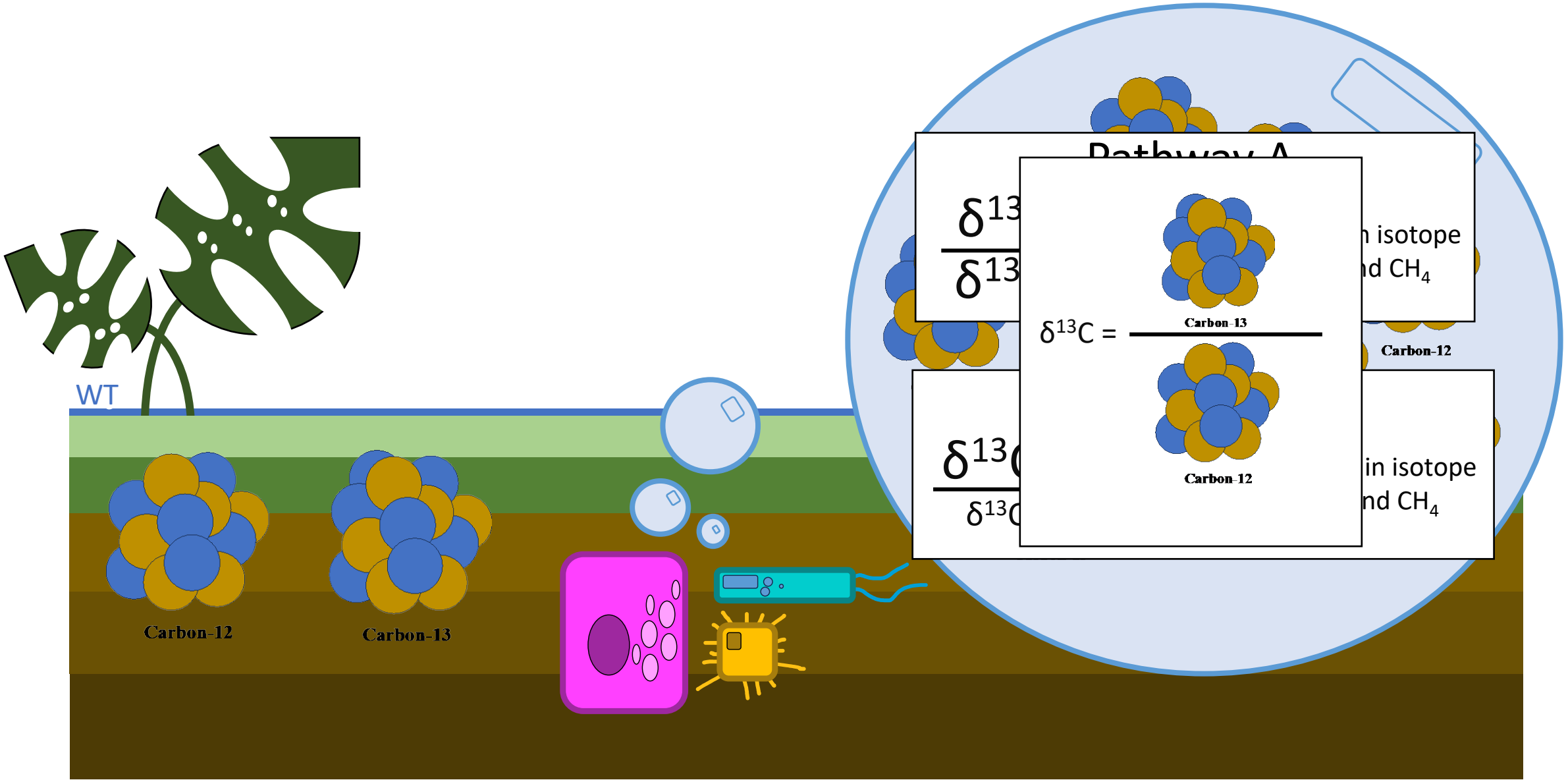


Carbon-14

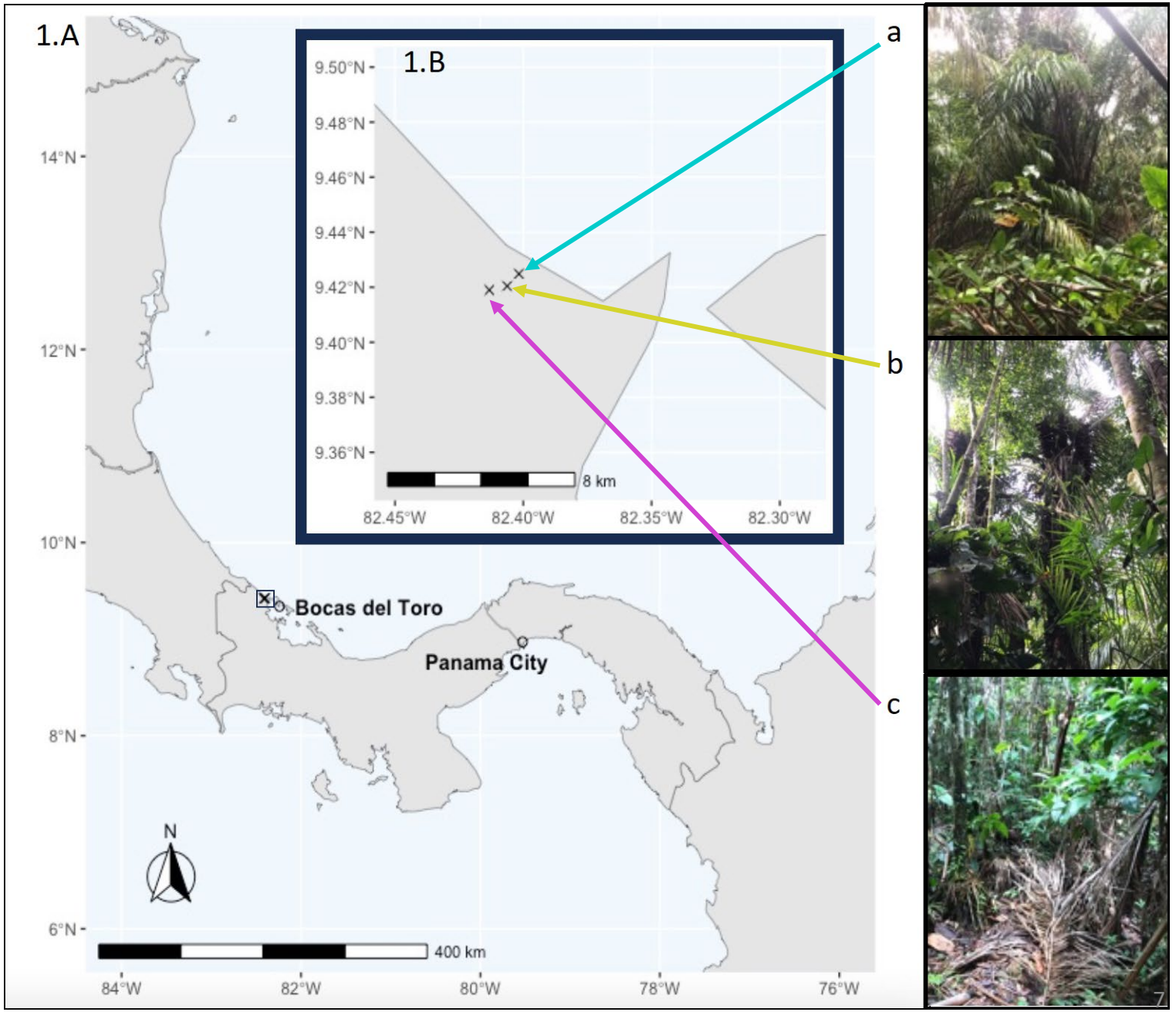
Rare

Unstable


Carbon-12
Carbon-13
Carbon-14
Rare
Unstable
Nitrogen-14
Carbon-12
Carbon-14
C-14
C-12
C-14
C-12
C-14
C-12
Younger
Shallow
Older
Deep


WT
Carbon-12
Carbon-13
Pathway A
δ^{13}
δ^{13}
n isotope
nd CH_4
Carbon-12
$\delta^{13}C$ =
Carbon-13
Carbon-12
δ^{13}
δ^{13}C
in isotope
nd CH_4

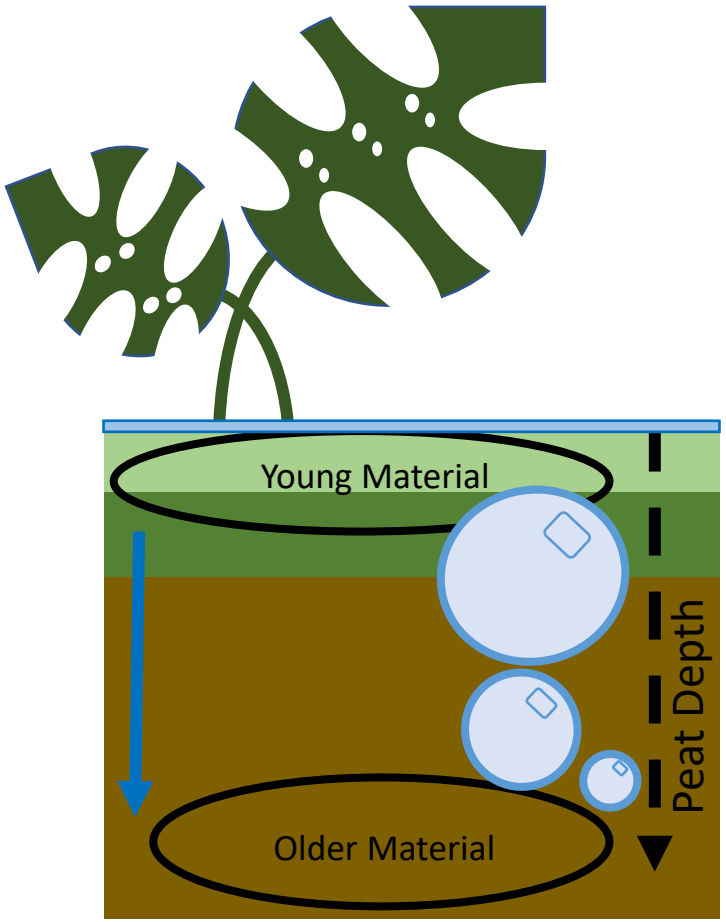
San San Pond Sak, Bocas Del Toro, Panama



How is carbon cycling within these soils?

Hypothesis 1:

Respired CO_2 and CH_4 is sourced from younger material

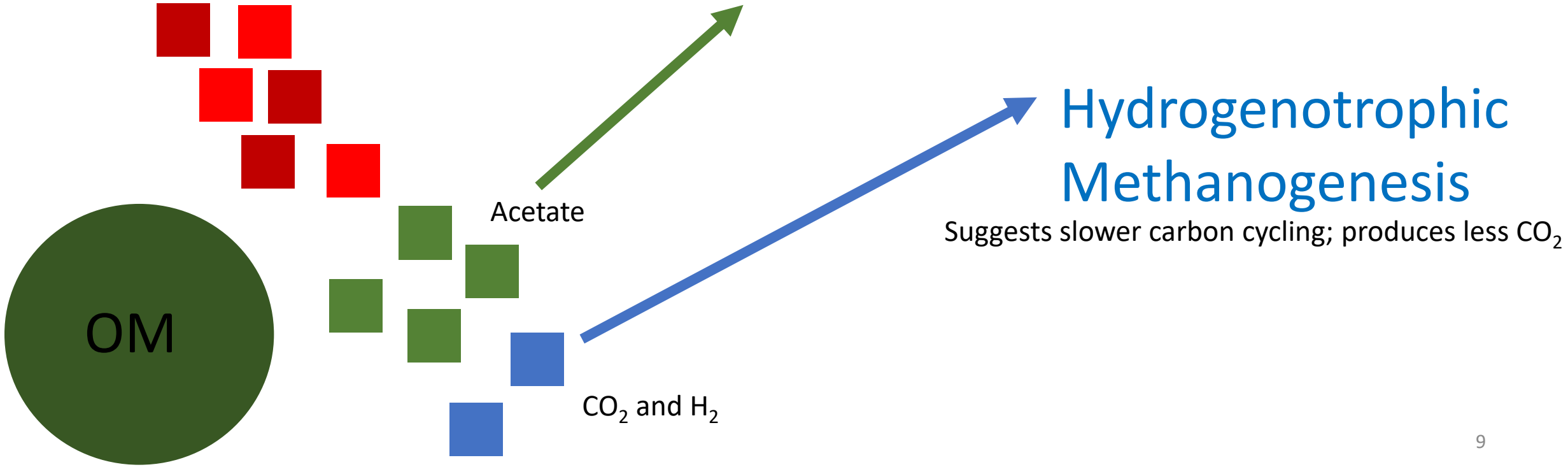


Is this bubble coming from microbial use of old peat or younger C?

How is carbon cycling within these soils?

Hypothesis 2:

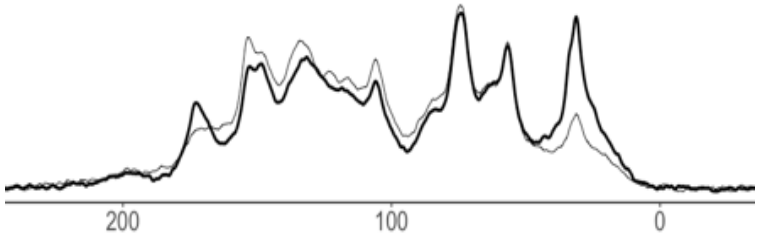
Hydrogenotrophic methanogenesis, not acetoclastic methanogenesis, is the dominant pathway of CH_4 production across the whole soil profile



Peat chemistry can help explain source selection and methane production pathway

Nuclear Magnetic Resonance Analysis - NMR

NMR Spectrometer



Example Spectra

Rapid Decomposition

Carbohydrates — More Aliphatic

Sugars, starch, simple protein

Cellulose

Fats, waxes, oils

Lignin — More Aromatic

Slow Decomposition

Sampling Design

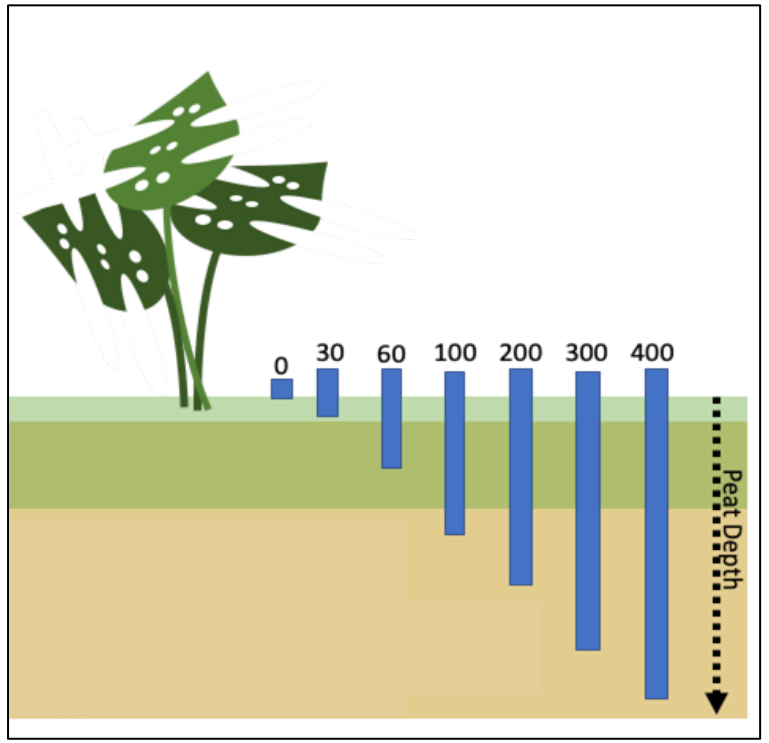
Hypothesis 1:

^{14}C Bulk peat soil

^{14}C Dissolved Organic Carbon

^{14}C Respiration products

NMR



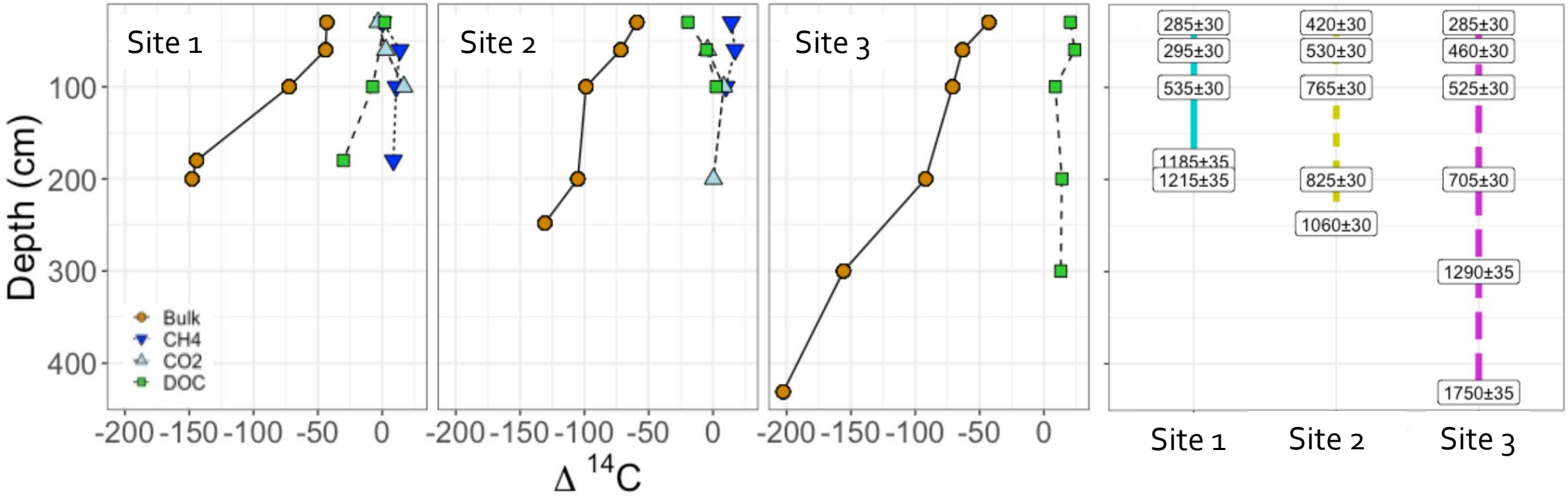
Hypothesis 2:

^{13}C Bulk peat soil

^{13}C Respiration products

Hypothesis 1

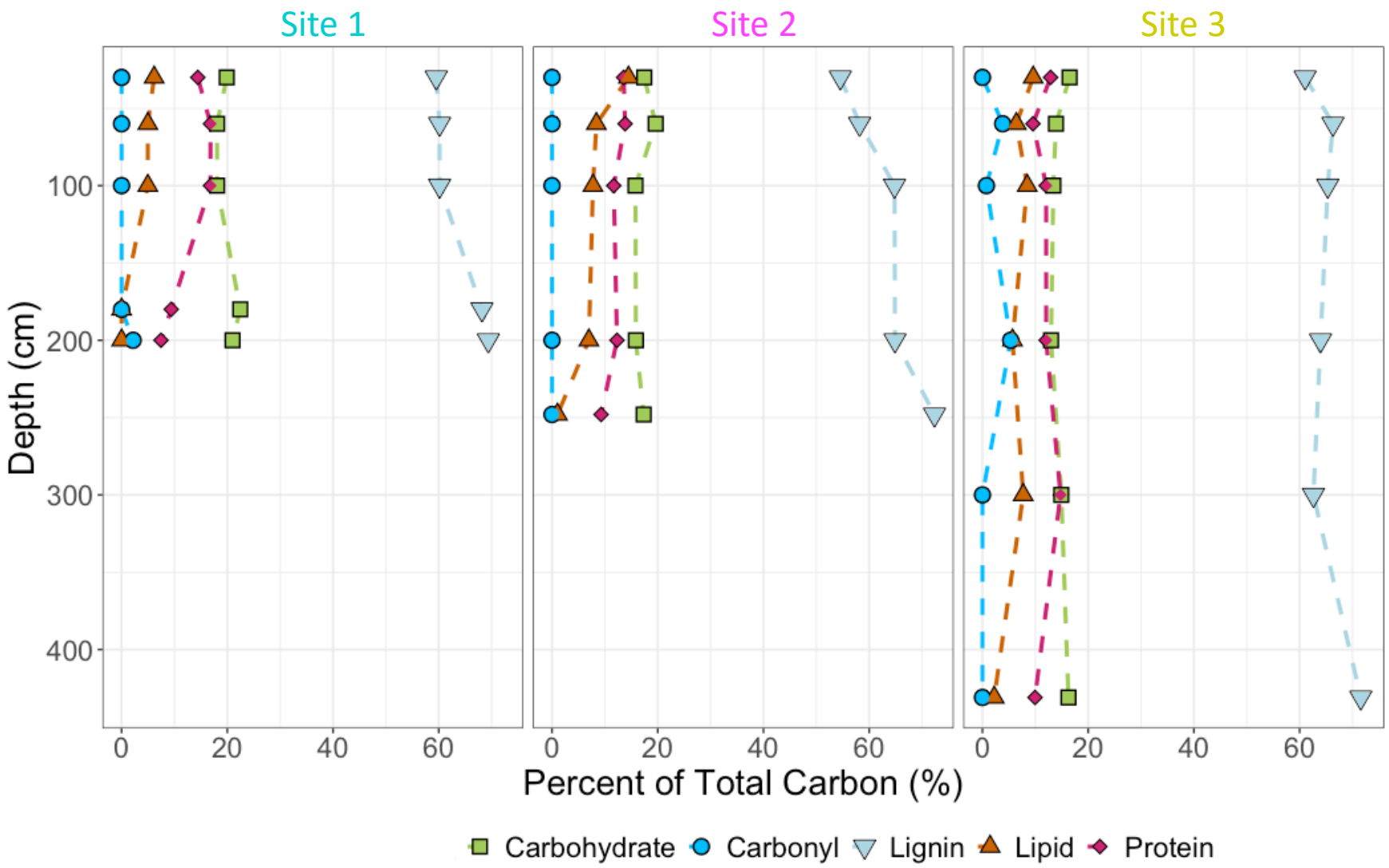
Bulk Peat is <u>old</u>
DOC is <u>modern</u>
<u>Gas values overlap DOC</u>



<u>Radiocarbon (△14C)</u>
Less depleted (less negative) = younger/more modern
More depleted (more negative) = older/less modern

Hypothesis 1

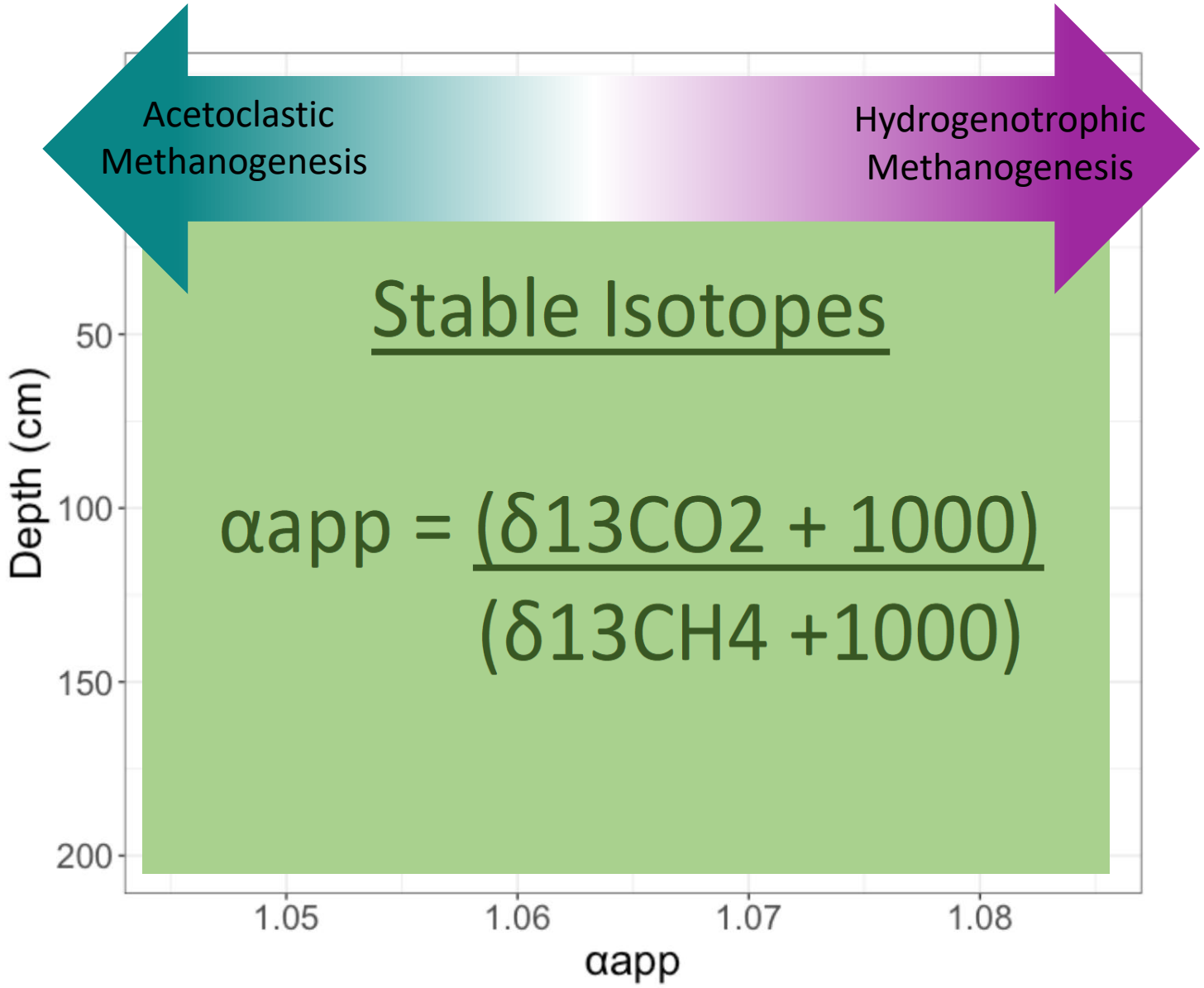
Bulk Peat is old
DOC is modern
Gas values overlap DOC



Preservation of bulk peat

Preferential use of surface DOC despite bulk peat being relatively bioavailable

Hypothesis 2



Bulk Peat is old
DOC is modern
Gas values overlap DOC

Preservation of bulk peat

Preferential use of surface DOC despite bulk peat being relatively bioavailable

Dominant pathway throughout the peat profile is hydrogenotrophic methanogenesis

How is carbon currently cycling within these soils?

Young carbon seems to be the dominant source of gas fluxes from deep peat

Chemically, bulk peat has the potential to decompose if exposed to aerobic conditions

Dominant pathway throughout the peat profile seems to be hydrogenotrophic methanogenesis

Thank You

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CAMS

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