Bulk Organic and Soil ^{14}C Analysis

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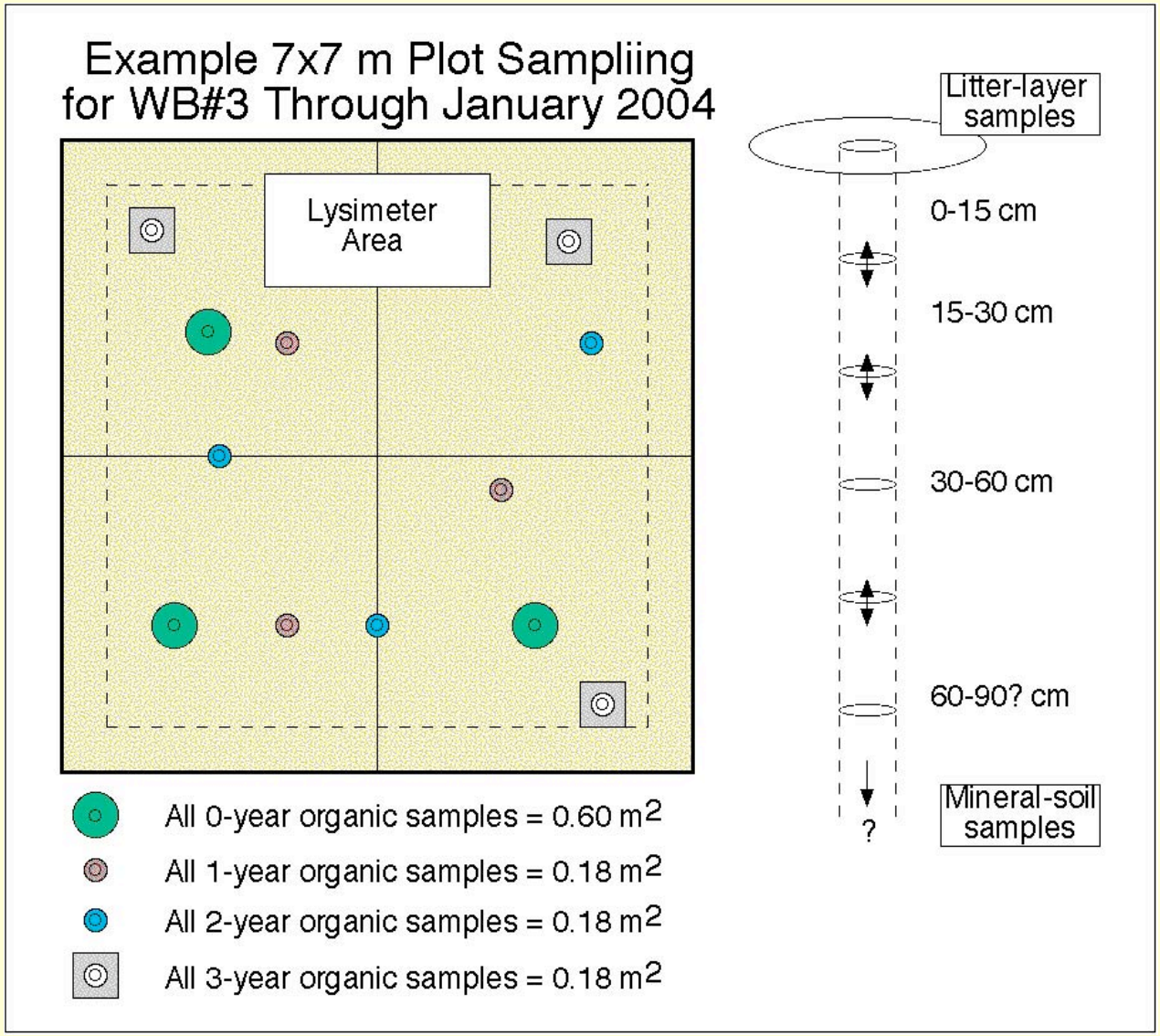


O_e horizon is minimal

0-15 cm is > A horizon

Depth of B horizon is highly variable

- **<4% of organic area and <0.3% of mineral area will have been sampled. How much sampling is too much?**

Organic Layers: O_i>1Y and O_e/O_a Combined

Mineral Soil Sampling

T0 = Jan 2001

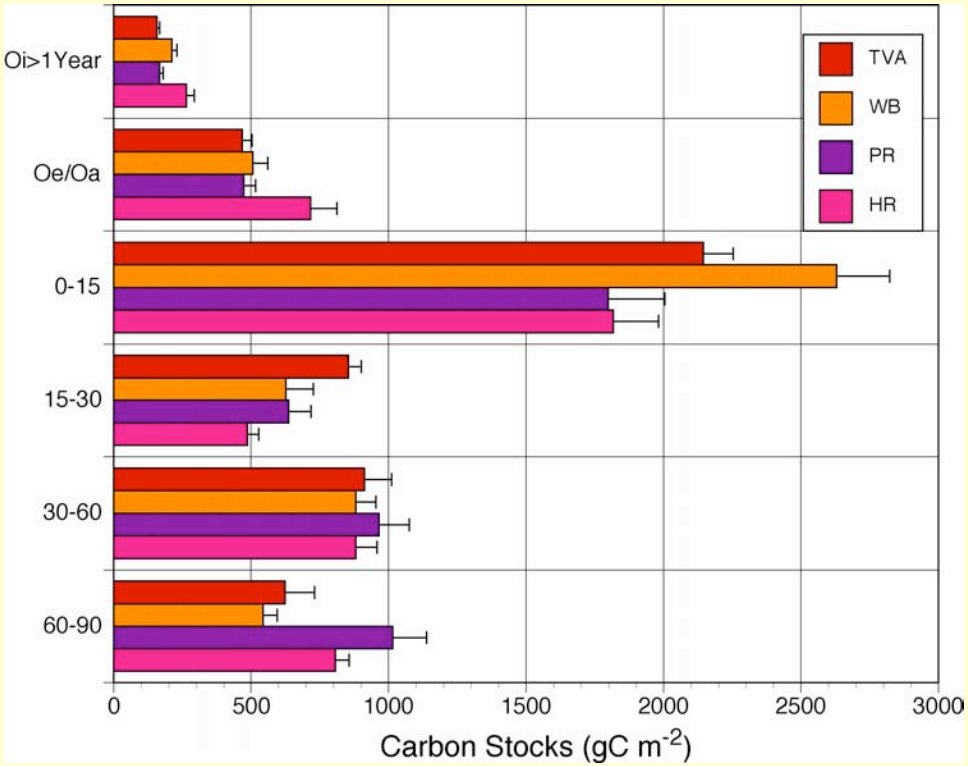
Y1 = Jan 2002

Y2 = Jan 2003

Y3 = Jan 2004

Initial C Stocks and ^{14}C-Signatures

Carbon Stocks By Horizon



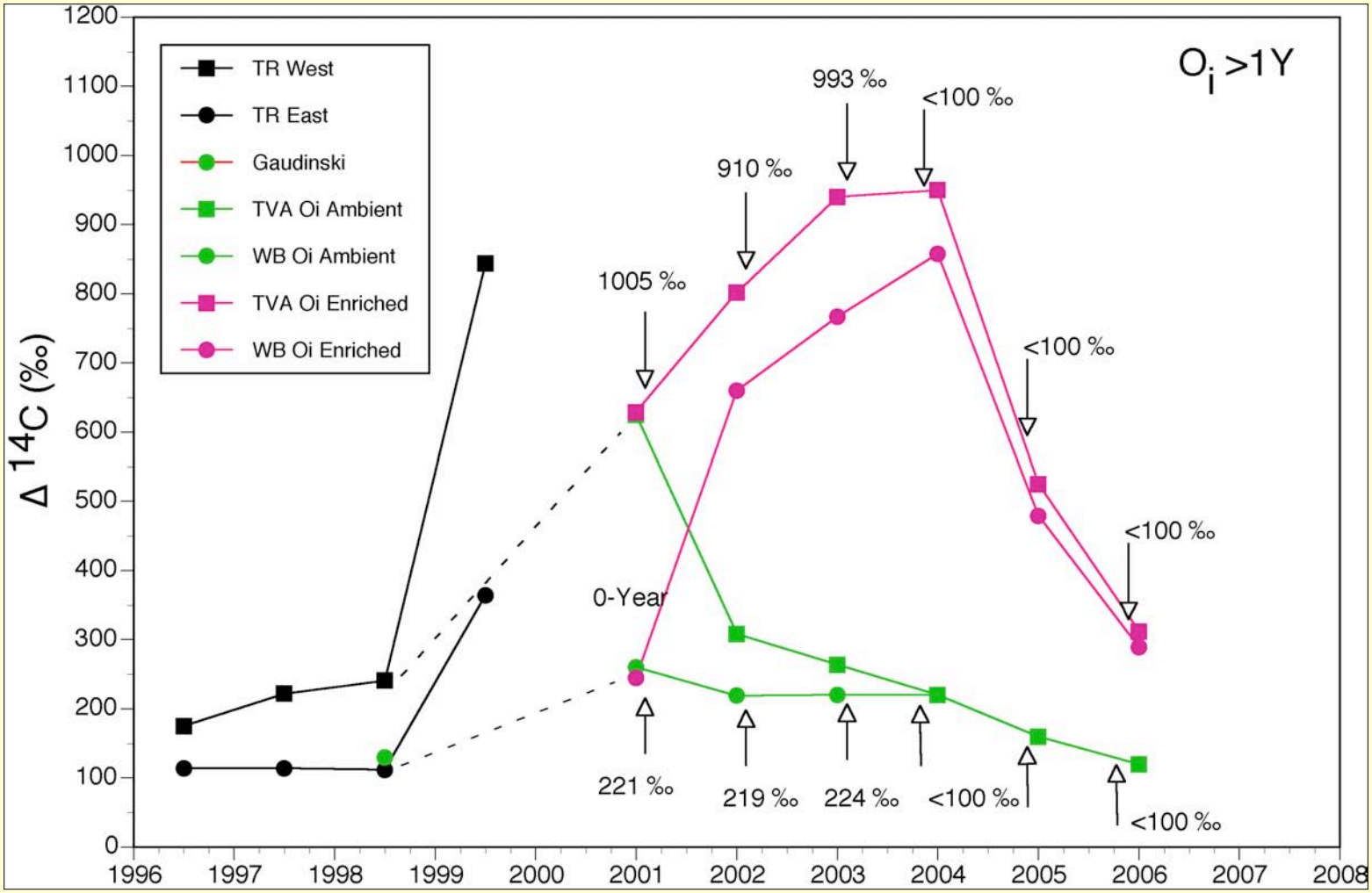
Time-zero ^{14}C (‰)

	TVA	WB	PR	HR
Oi>1Y	627	252	515	193
Oe/Oa	466	218	361	194
0-15	192	84	163	121
15-30	95	24	92	72
30-60	62	7	40	72
60-90	-104	-90	58	35

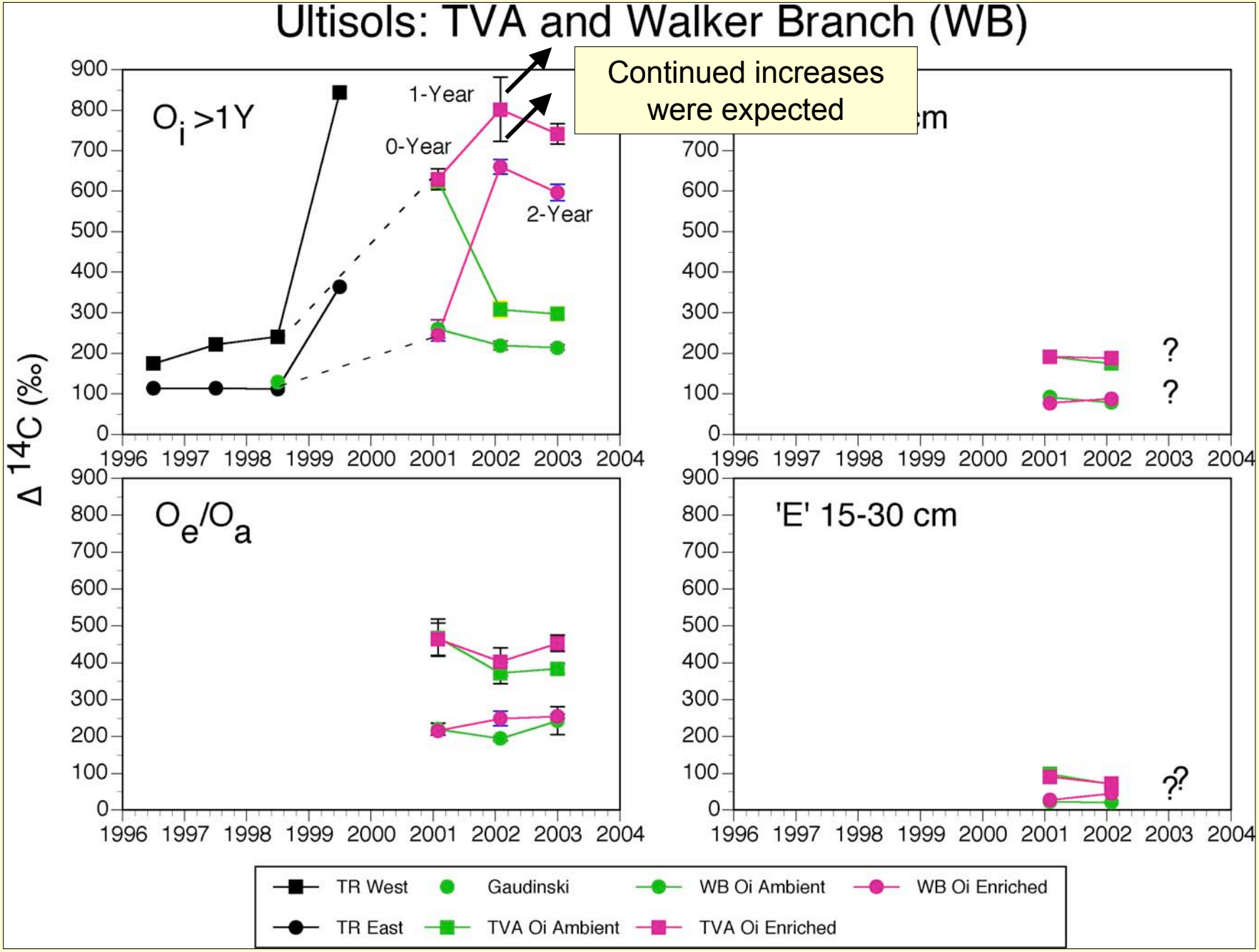
Inter-Annual Bulk ^{14}C Data

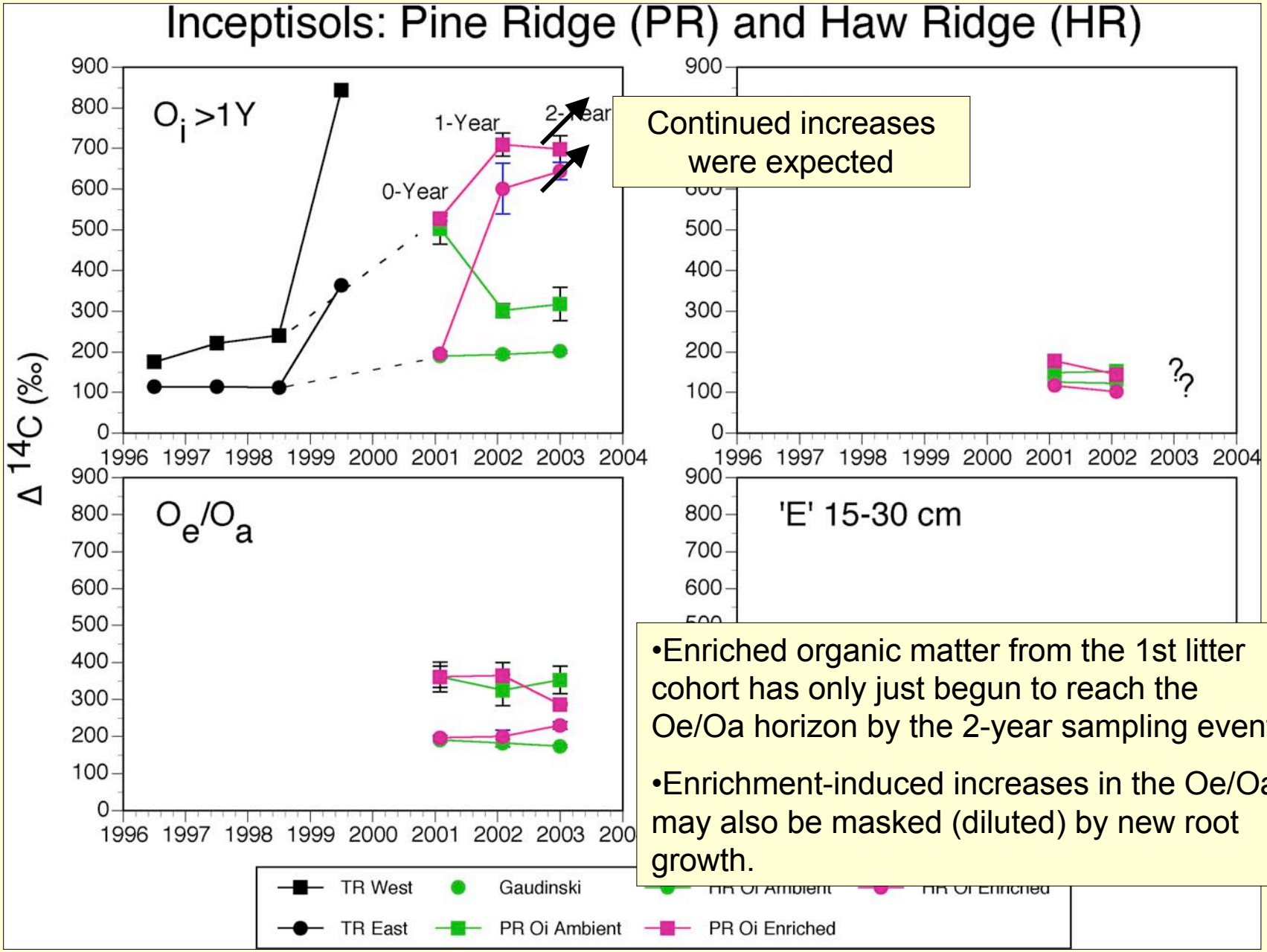
- The following graphs contrast ^{14}C-signatures of pre-study tree ring sapwood rings (TR) for eastern and western trees with bulk ^{14}C data for organic layers (Oi, Oe/Oa) or mineral soil depths/horizons (A,E).
- Time zero measurements for the experiment are the January 2001 data.

Initial Expectations



$$^{14}C^*[C_{Oi}] = {}^{14}C^*[C_{C1}] + {}^{14}C^*[C_{C2}] + {}^{14}C^*[C_{C3}]$$


Ultisols: TVA and Walker Branch (WB)
Continued increases were expected
O_i >1Y
1-Year
0-Year
2-Year
O_e/O_a
'E' 15-30 cm
?
?
??
$\Delta^{14}C$ (‰)
0
100
200
300
400
500
600
700
800
900
1996
1997
1998
1999
2000
2001
2002
2003
2004
TR West
TR East
Gaudinski
TVA Oi Ambient
WB Oi Ambient
TVA Oi Enriched
WB Oi Enriched



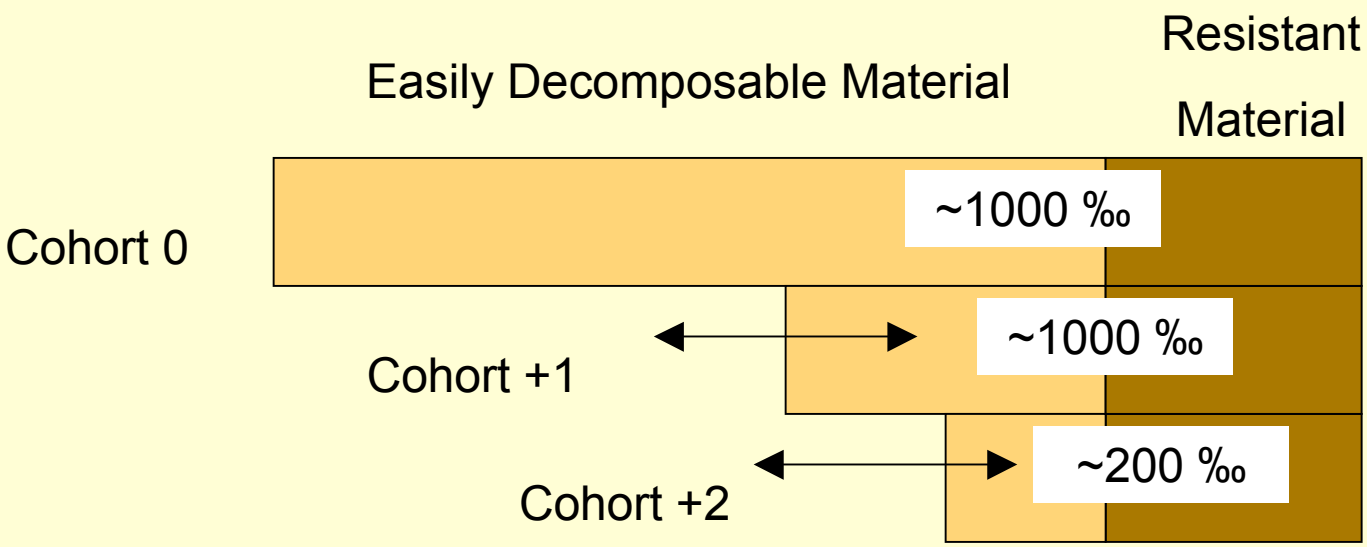
Continued increases were expected

- Enriched organic matter from the 1st litter cohort has only just begun to reach the Oe/Oa horizon by the 2-year sampling event.
- Enrichment-induced increases in the Oe/Oa may also be masked (diluted) by new root growth.

Results Through Year-2

- After one year of enriched (1005‰) or background (221‰) litter additions (2002 data points), recognizable litter greater than 1-year of age (Oi>1Y) showed the expected patterns of enrichment or dilution. There was little evidence of new C movement below the Oi horizon after one year.
- Surprisingly, after the second year of enriched litter additions (910‰) the Oi and Oe/Oa ^{14}C-signatures did not continue to increase for the 'enriched' treatment plots.
- Reasons?
  - Not sampling error or wind disturbance
  - Differential decomposition of individual litter cohorts in one year vs. another
  - Differential labeling of soluble (or labile) and bulk litter fractions
  - Preferential removal of newly added material by macrobiota?

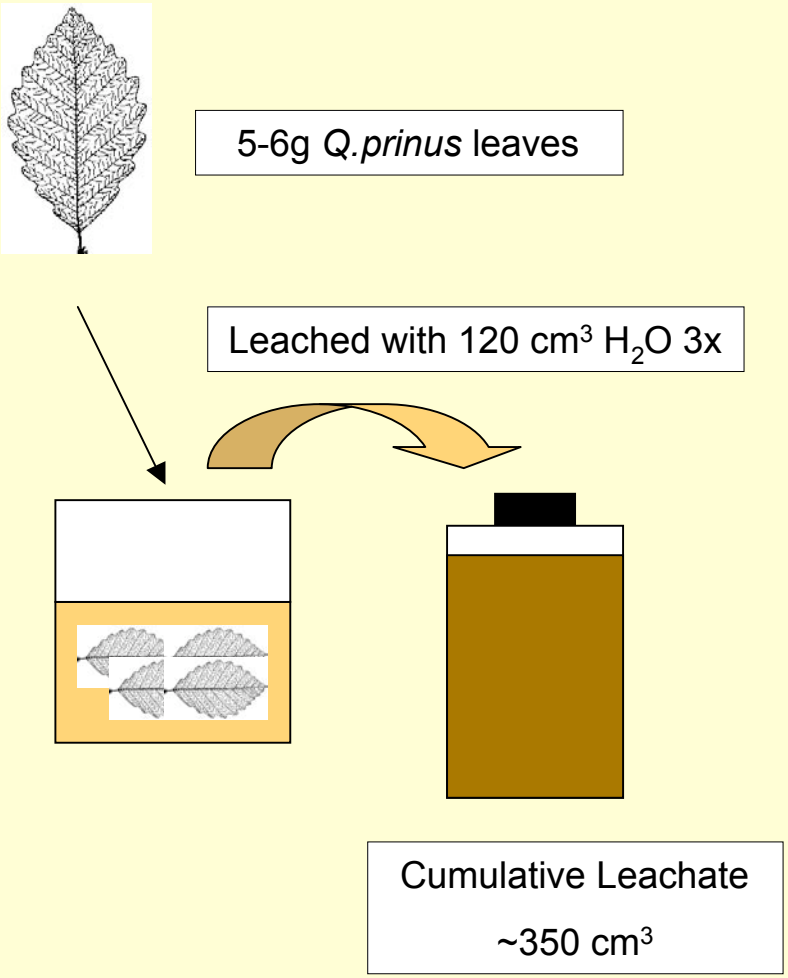
Oi-layer Includes Multiple Cohorts



In a stable system all material has a similar ^{14}C-signature, however, in our experiment we are analyzing a mixture of materials.

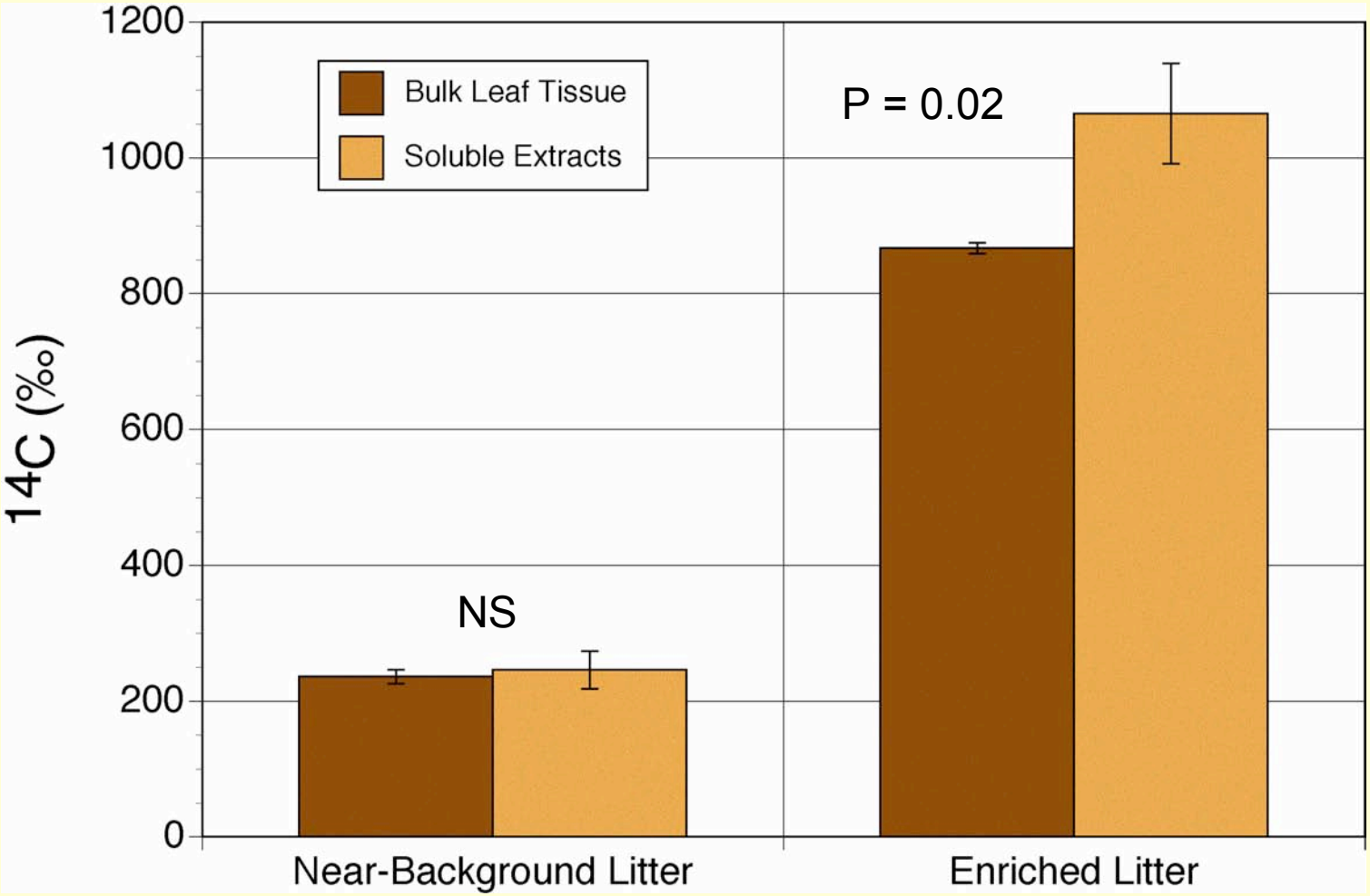
^{14}C of Bulk Tissue vs. DOC

- **Archived and 'fresh' *Quercus prinus* leaves from either near-background or enriched litter sources were selected for leaching.**
- **Leached 3 times including 30 minutes shaking and steeped at ~2 °C for 24 hours.**
- **Pre-leached bulk leaf material and the cumulative leachate containing dissolved organic carbon were analyzed for carbon and its ^{14}C-signature.**



Leaching Results

- Mean leachate [C] was 378 µg cm^{-3} and did not differ by litter source (near-background vs. enriched).
- Triplicate leachings removed between 2 and 3 % of the original mass depending on an evaluation of leachate C recovered vs. bulk tissue mass loss, respectively.



- **Near-background tissues have uniform ^{14}C-signatures.**
- **Soluble materials leaching from enriched litter have a significantly higher ^{14}C-signatures, and this characteristic is critical to modeling C movement.**

Organic Horizon Modeling Issues

- **Tracking litter cohorts is important**
- **The influence of inter- and intra-annual weather conditions must be known to capture decomposition processes.**
- **The ^{14}C-signatures of litter chemical fractions is important, and the contribution of individual species needs further evaluation**
  - ***Quercus prinus, Q. alba* and *Q. velutina*, *Acer rubrum*, *Nyssa sylvatica*, *Liriodendron tulipifera*.**
- **Leaching and movement of C as DOC out of the organic horizons must be quantified.**