Dendrochemistry

- Measurement and environmental interpretation of elements in rings
- Not including stable isotopes (C,H, O)

Potential Applications

- Acid rain (N, S, Al)
- Nutrient imbalances (K, P, Mg, Ca)
- Heavy metal contam (Pb, Ni, Cd, Hg)
- Radioactives (U, Cs)

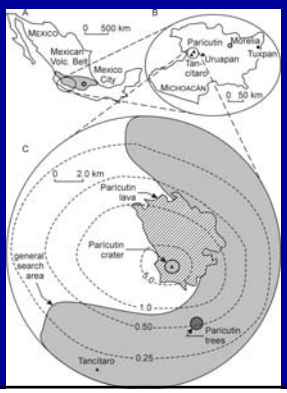
It seems so logical, but …

- Biological use of elements
- Translocation
- Sapwood uptake
- Xylem storage

Assuming you try anyway …

- Site and tree selection: huge
- Crossdating: nice, but perhaps negotiable
- Uniformitarianism: still applies
- Replication: essential, but costly
- Contamination: new level of sample care

Parícutin

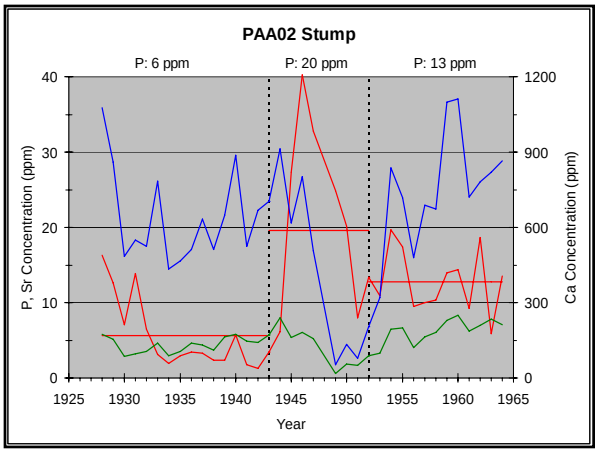


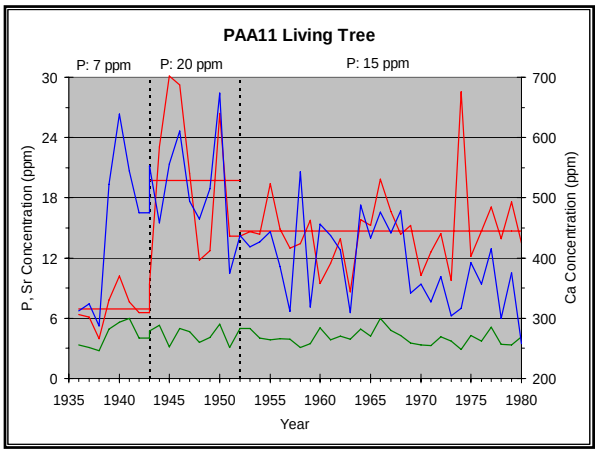

MAPA DE LA COMUNIDAD INDIGENA
N

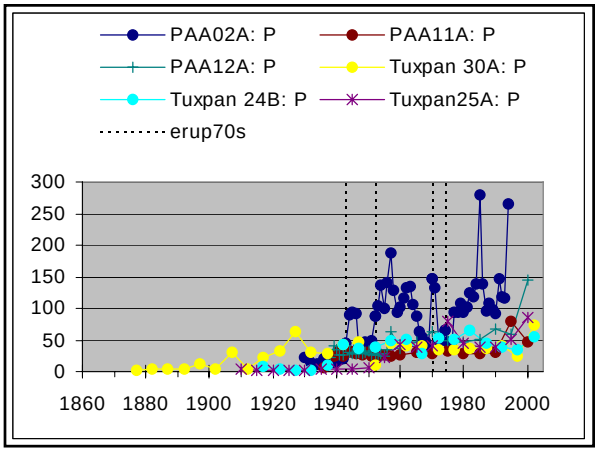
El Tocón Paricutinense

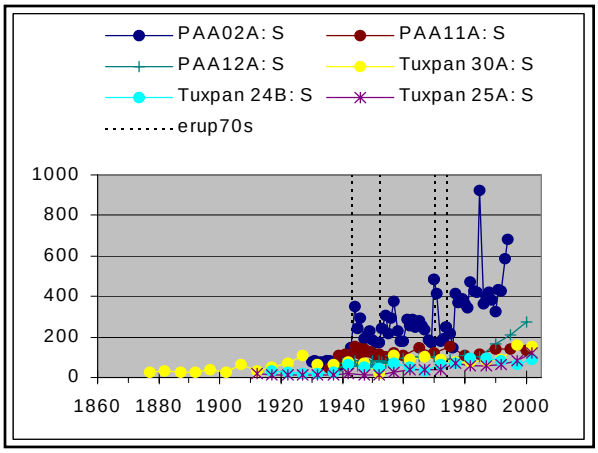
Other Elements: LA-ICP-MS

- Laser Ablation
  - Converts wood to gas
- Inductively Coupled Plasma
  - Energizes gas
- Mass Spectroscopy
  - Counts elements




PAA11 Living Tree
P: 7 ppm
P: 20 ppm
P: 15 ppm
P, Sr Concentration (ppm)
Ca Concentration (ppm)
Year
0
6
12
18
24
30
200
300
400
500
600
700
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980


PAA02A: P
PAA11A: P
PAA12A: P
Tuxpan 30A: P
Tuxpan 24B: P
Tuxpan25A: P
erup70s
0
50
100
150
200
250
300
1860
1880
1900
1920
1940
1960
1980
2000


PAA02A: S
PAA11A: S
PAA12A: S
Tuxpan 30A: S
Tuxpan 24B: S
Tuxpan 25A: S
erup70s
0
200
400
600
800
1000
1860
1880
1900
1920
1940
1960
1980
2000

Conclusions: Parícutin

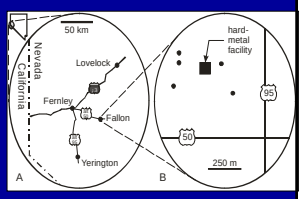
- Crossdating difficult, but doable
- Visible responses exist
- Chemical responses interesting
  - Increase in phosphorus
    - Direct addition of ionic P

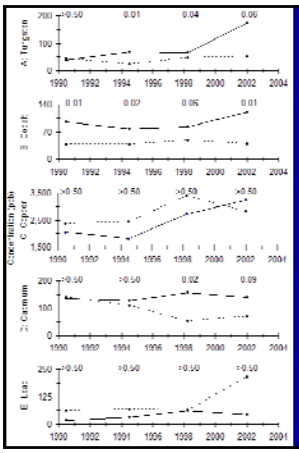
Childhood Leukemia in the West

- Expected rate:
  - 4.2/100,000 children/year
- Fallon (2,383 kids):
  - 17 cases (17x)
- Sierra Vista (11,287):
  - 12 cases (2.5x)
- Florin (9,738)
  - 11 cases (2.6x)

Methods

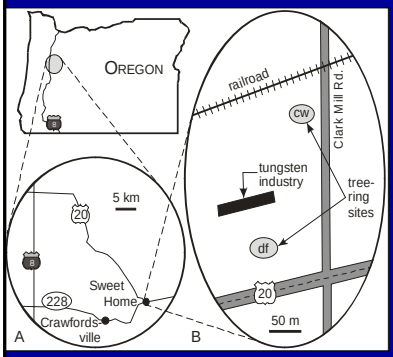
- Tree-core samples
  - Within LAA
  - Outside LAA
  - Urban species
- Composite years
  - Before leukemia
  - Since leukemia
- ICP-MS for metals





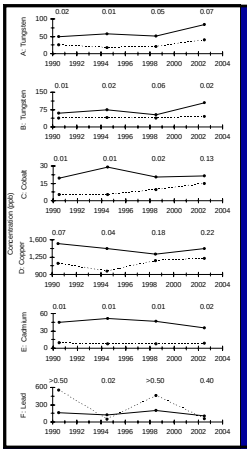
Within Fallon

- Significant Increase in tungsten
  - Nothing in other towns
- Cobalt always high
- Other metals: nothing much



Repeat entire project:

Sweet Home, Oregon



- Tungsten increases in SH, less so outside
- Cottonwoods more sensitive than D-firs
- Other metals: nothing much

Dendrochemistry Conclusion

- Tungsten could be environmentally meaningful
- Tungsten merits additional research
  - Biomedical: very little published
    - HMTA: human osteoblast cells to tumorigenic phenotype (Miller 2002)
    - Retained tungsten stored in bones (Kaye 1968)

CDC: Urine and tap water samples

	Tungsten concentration (µg/L)	
Location	Children	Tap Water
Churchill	2.31	4.66
Lovelock	0.62	0.11
Yerington	1.18	3.32
Pahrump	0.56	0.04
National Average	0.10 – 0.15	

A Global Glut of Nitrogen

Global Sources of Biologically Available (Fixed) Nitrogen)

ANTHROPOGENIC SOURCES	ANNUAL RELEASE OF FIXED NITROGEN (teragrams)
Fertilizer	80
Legumes and other plants	40
Fossil fuels	20
Biomass burning	40
Wetland draining	10
Land clearing	20
Total from human sources	**210**
NATURAL SOURCES	
Soil bacteria, algae, lightning, etc.	140

Source: Peter M. Vitousek *et al.*, "Human Alteration of the Global Nitrogen Cycle: Causes and Consequences," *Issues in Ecology*, No. 1 (1997), pp. 4-6.

Dendrochemistry of Nitrogen

Can ring-N elucidate N availability of the past?

N mobility (sap chemistry)

Poulson et al. (1995): “N concentration variation in tree rings cannot provide information on past environmental availability of N …”

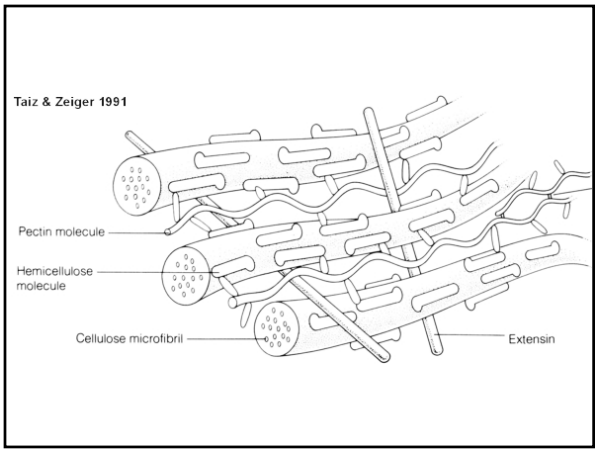
What If Wood Is “Cleaned”?

Heartwood extractives: No N, but mass

Sapwood: Sap has organic N compounds

Cell walls have N

Does this component reflect N availability at time of ring formation?



Wood Treatments

Chemical Treatments
- Organic solvents
- Oxidizers
- Reducers

Physical Treatments
- Autoclaving
- Microwaving
- Pulverizing

Study Details

Loblolly pine of North Carolina

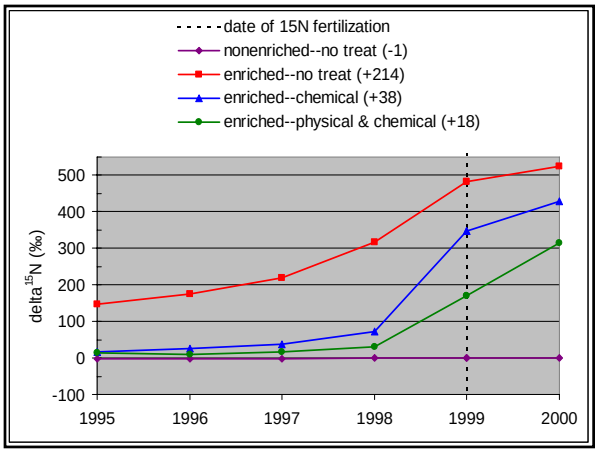
6-year-old trees in 2001

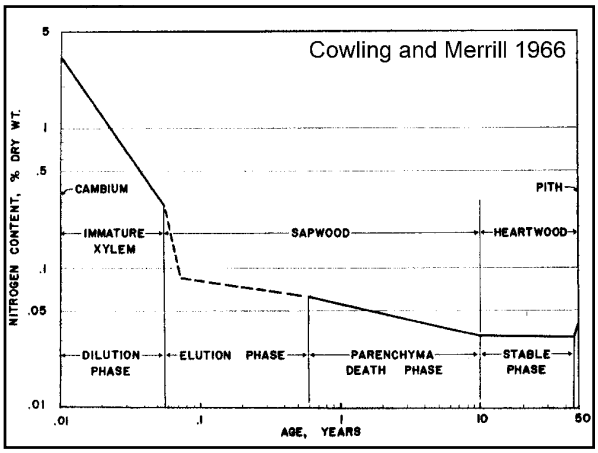
All trees N fertilized every year

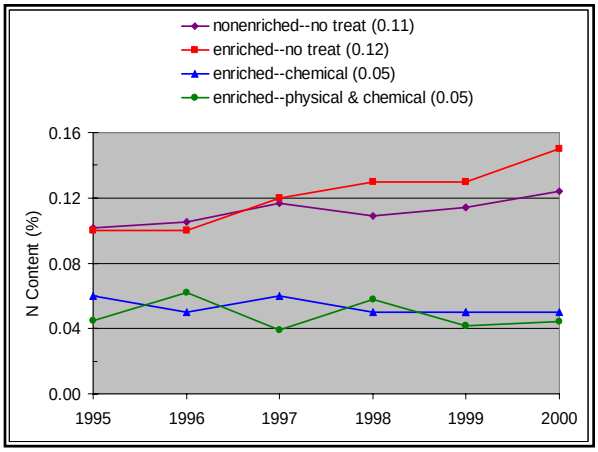
Some trees ^{15}N enriched in their 5th year (1999)

Other trees left at natural abundance

Pre-enriched $\delta^{15}N$ = natural abundance?




Cowling and Merrill 1966
NITROGEN CONTENT, % DRY WT.
5
1
.5
.1
.05
.01
CAMBIUM
PITH
IMMATURE XYLEM
SAPWOOD
HEARTWOOD
DILUTION PHASE
ELUTION PHASE
PARENCHYMA DEATH PHASE
STABLE PHASE
.01
.1
1
10
50
AGE, YEARS


nonenriched--no treat (0.11)
enriched--no treat (0.12)
enriched--chemical (0.05)
enriched--physical & chemical (0.05)
N Content (%)
0.16
0.12
0.08
0.04
0.00
1995
1996
1997
1998
1999
2000