Dates


CARBON DATING
WOULD YOU LIKE TO GO OUT TO A MOVIE WITH ME?
searchID: cgr0238
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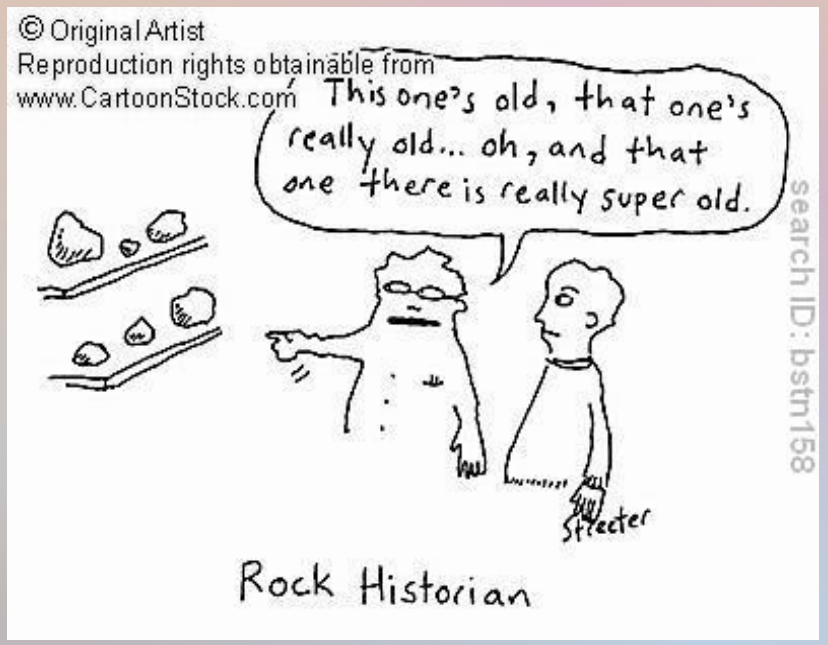
CHARGER

Types of dates

No uncertainties

Yearly resolution

Decadal / centennial – (multi-) millennial resolution



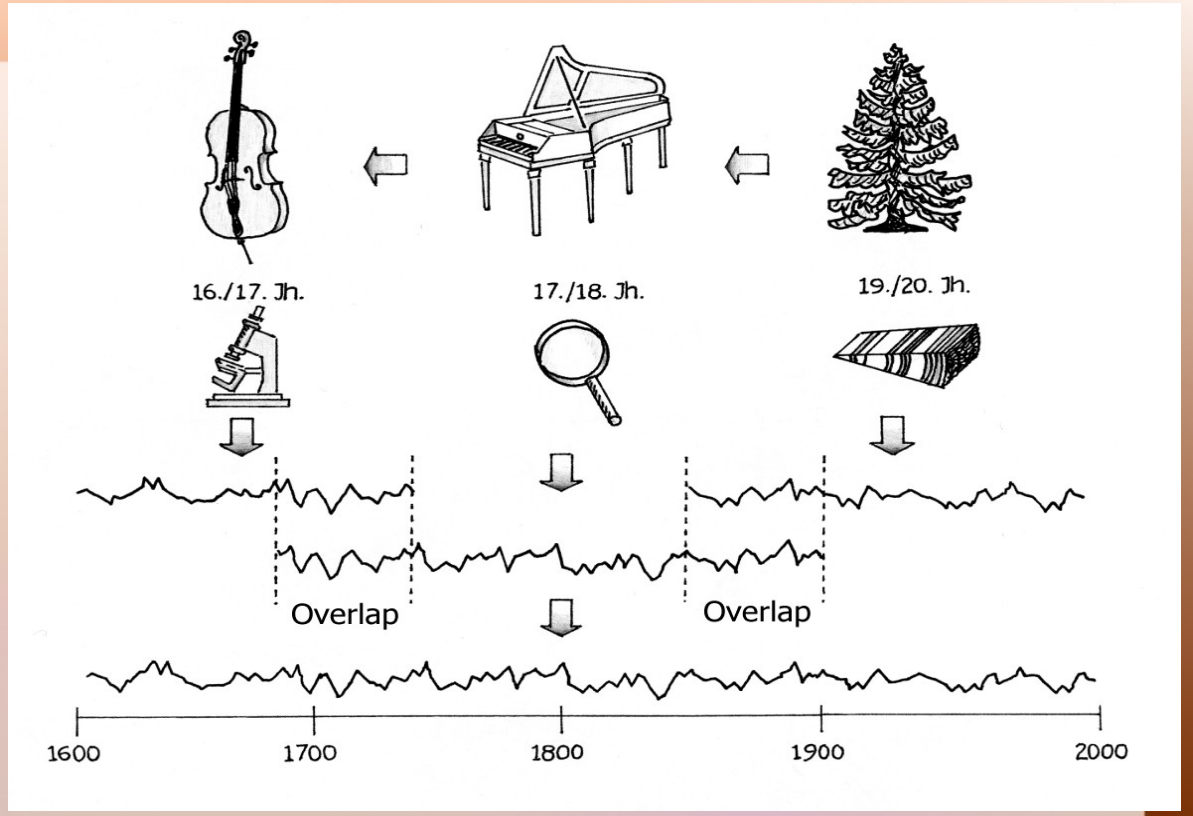
Dates without uncertainties

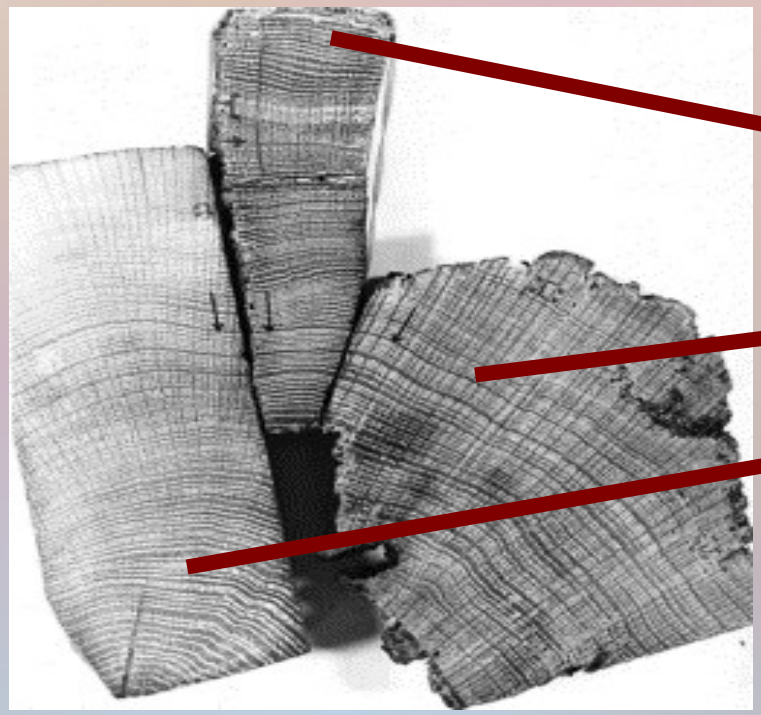
Historical information

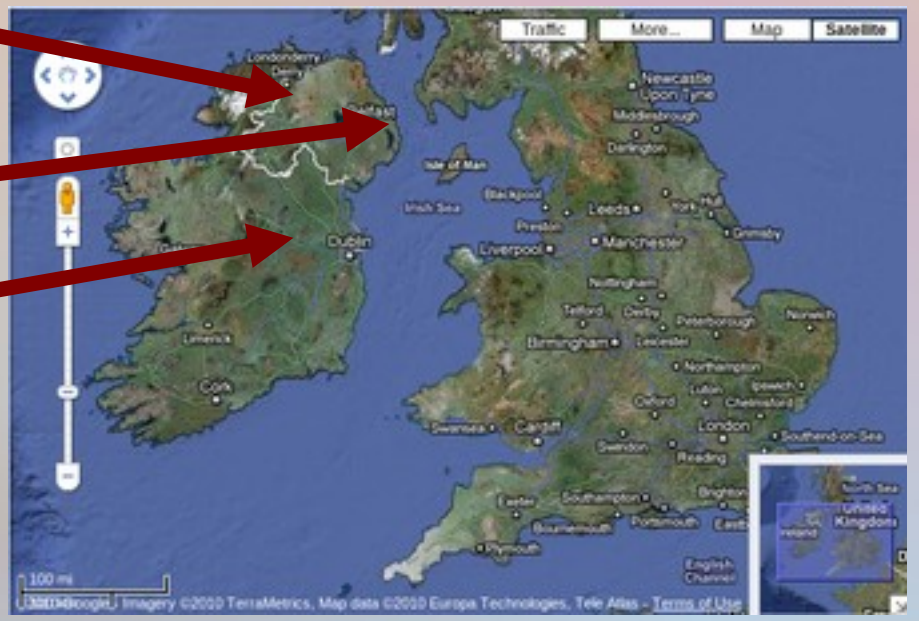
Dendro-dated trees

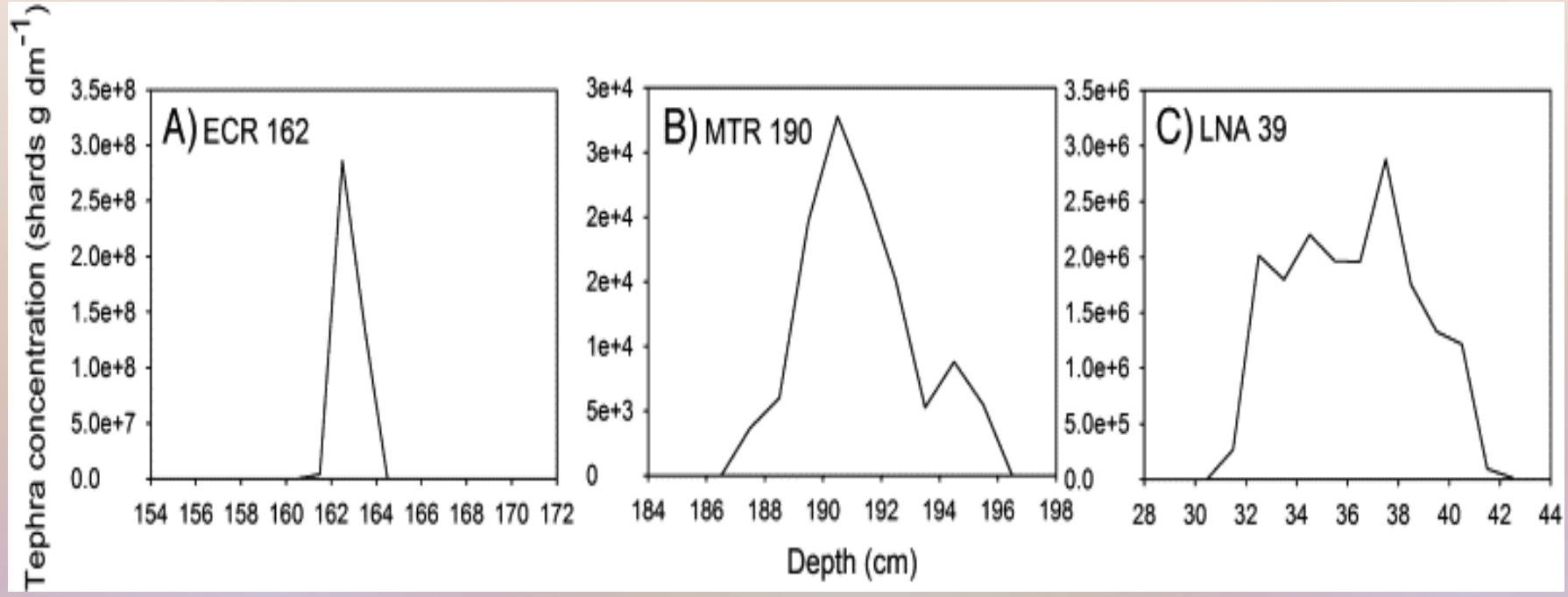
Tephra

- But, identified with 100% confidence?
  - Geochemistry, stratigraphy
- Depth known exactly?


16./17. Jh.
17./18. Jh.
19./20. Jh.
Overlap
Overlap
1600
1700
1800
1900
2000




Traffic
More...
Map
Satellite
Dublin
Liverpool
Manchester
Leeds
London
Cork
Limerick
Birmingham
Newcastle Upon Tyne
Middlesbrough
Darlington
Nottingham
Northampton
Southend-on-Sea
Southampton
Portsmouth
Plymouth
Swansea
Cardiff
Reading
Oxford
Ipswich
Norwich
Peterborough
Grimsby
Hull
Preston
Blackpool
Irish Sea
Isle of Man
English Channel
100 mi
Imagery ©2010 TerraMetrics, Map data ©2010 Europa Technologies, Tele Atlas - Terms of Use



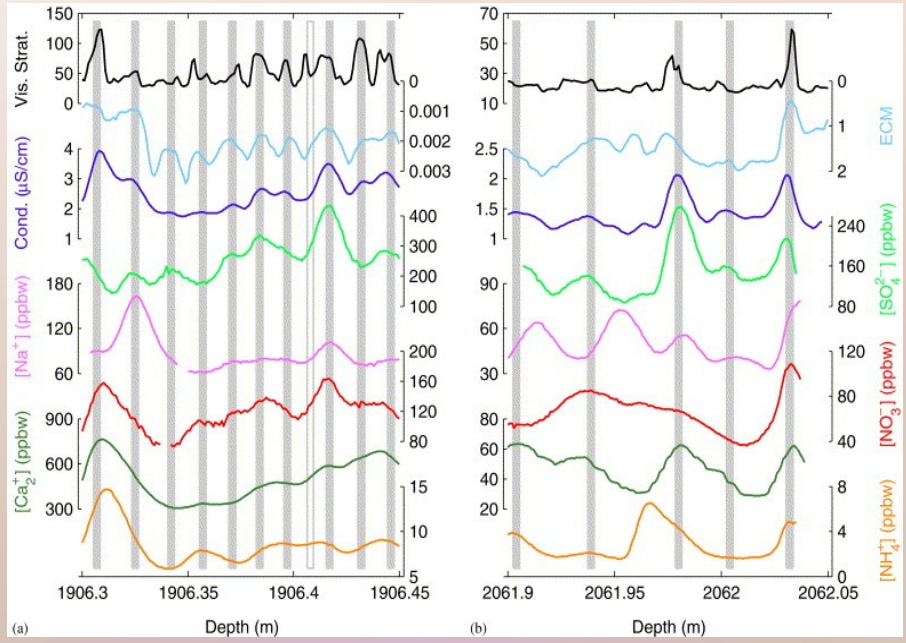
Payne & Gehrels, 2010. The formation of tephra layers in peatlands: An experimental approach. *Catena* 81:12-23

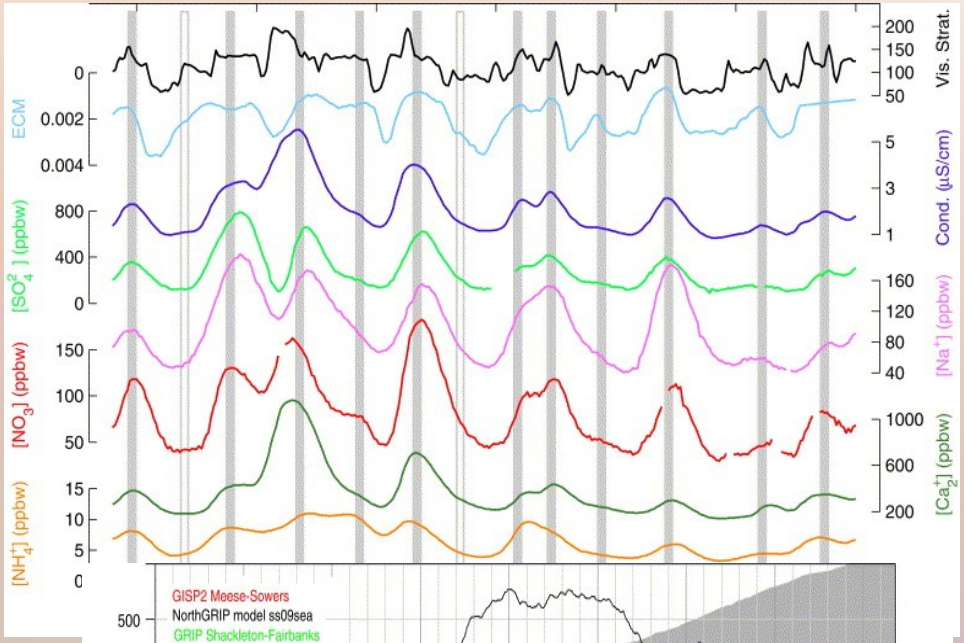
Dates with annual uncertainties

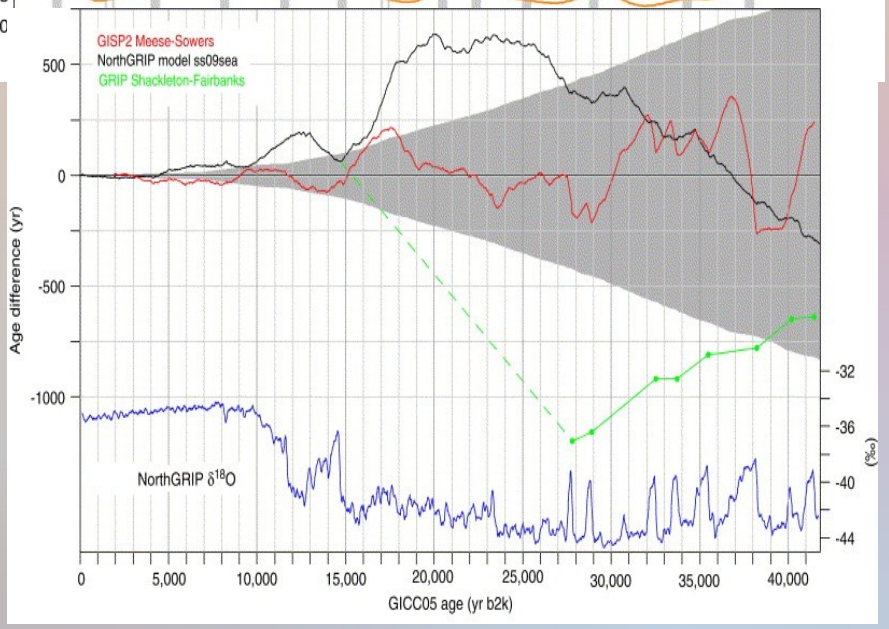
Layer counting of deposits (ice, varved lakes)

^{210}Pb, post-bomb ^{14}C

Annually layered ice cores







The Greenland Ice Core Chronology 2005, 15–42 ka. Part 1, Part 2. Quaternary Science Reviews 25

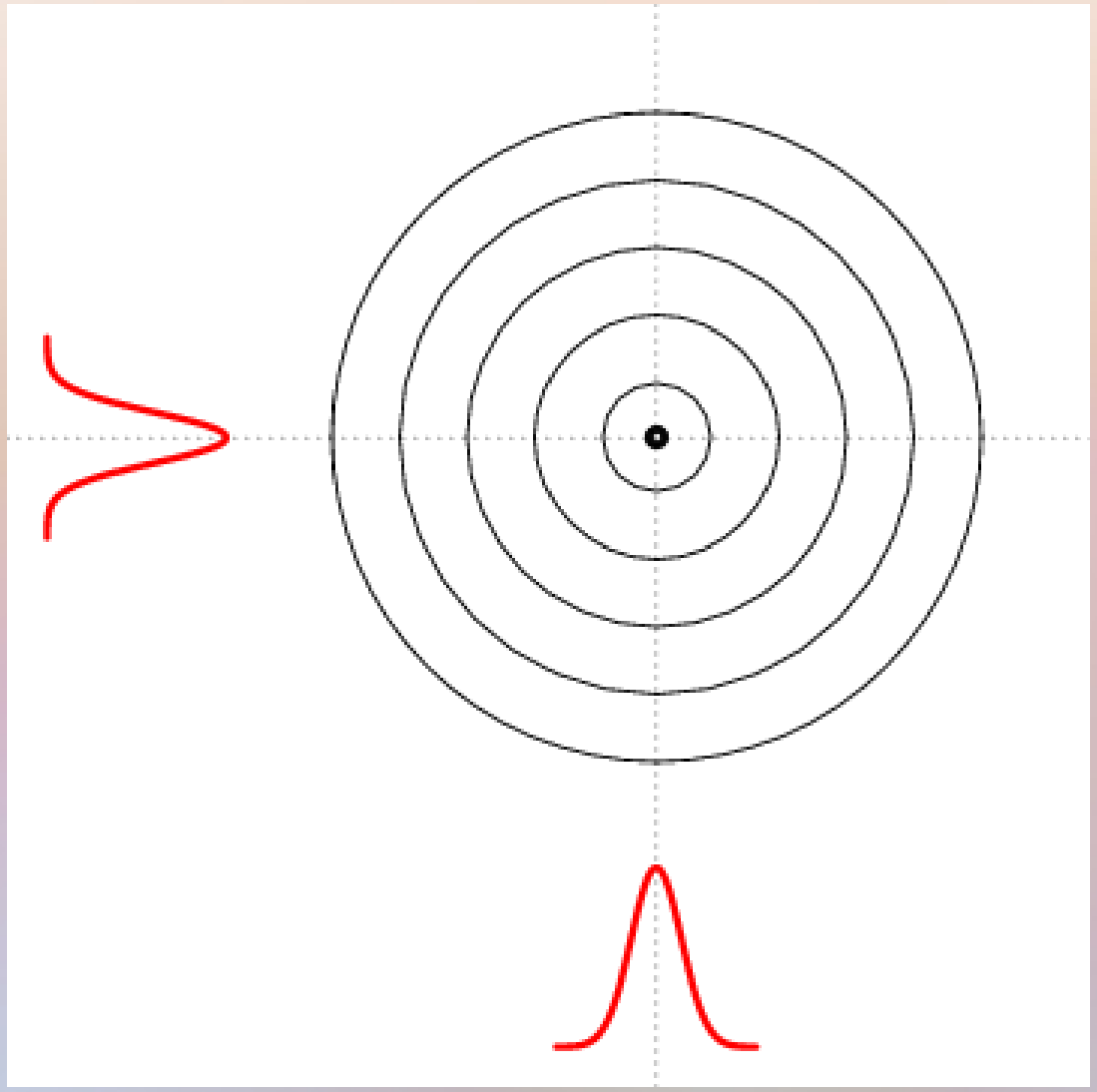
Decadal-millennial uncertainties

OSL, U/Th

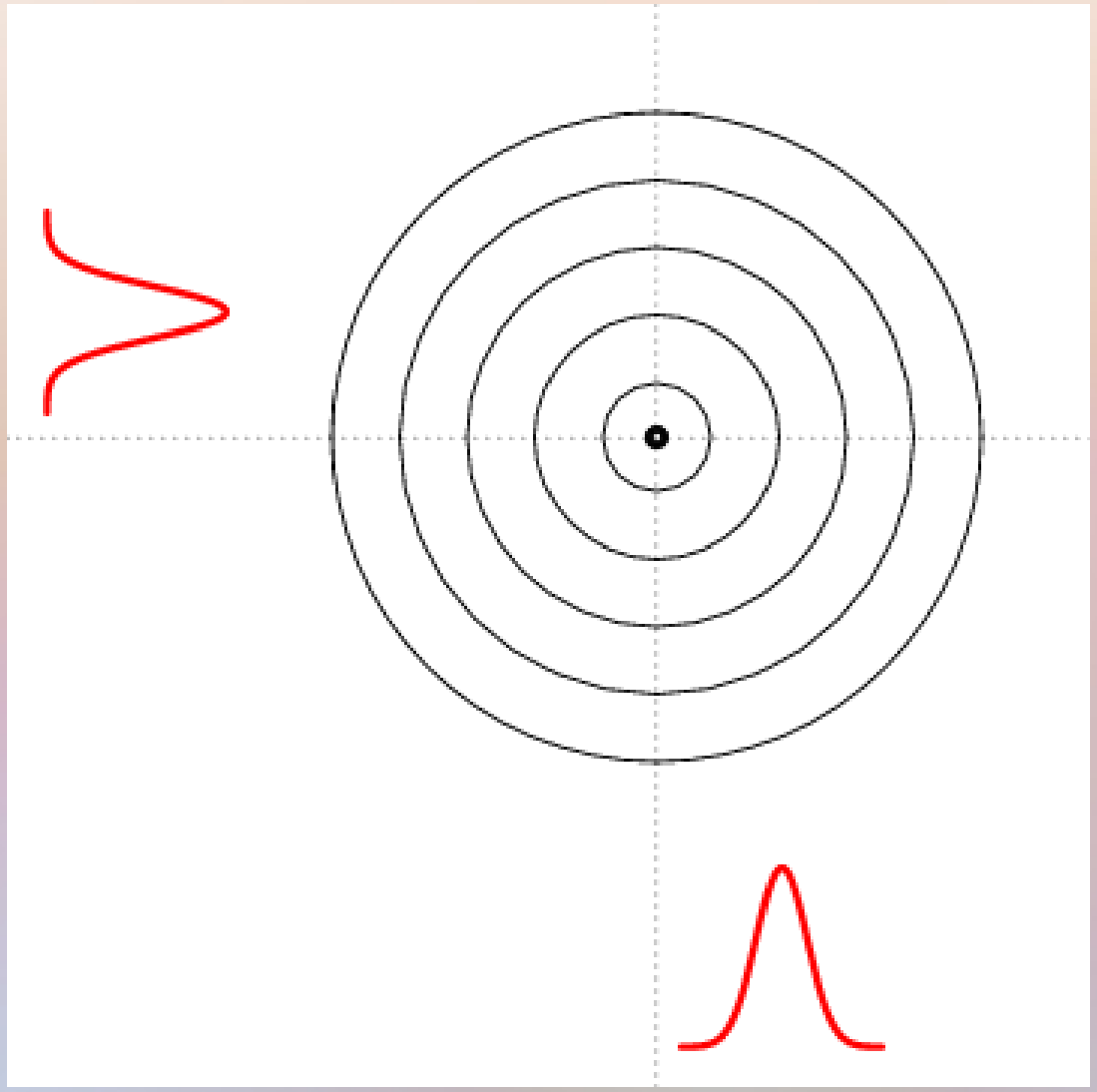
^{14}C

- Preparation
- Contamination problems
- Measurement uncertainties
- Age offsets (spatiotemporal variation)
- Need for calibration

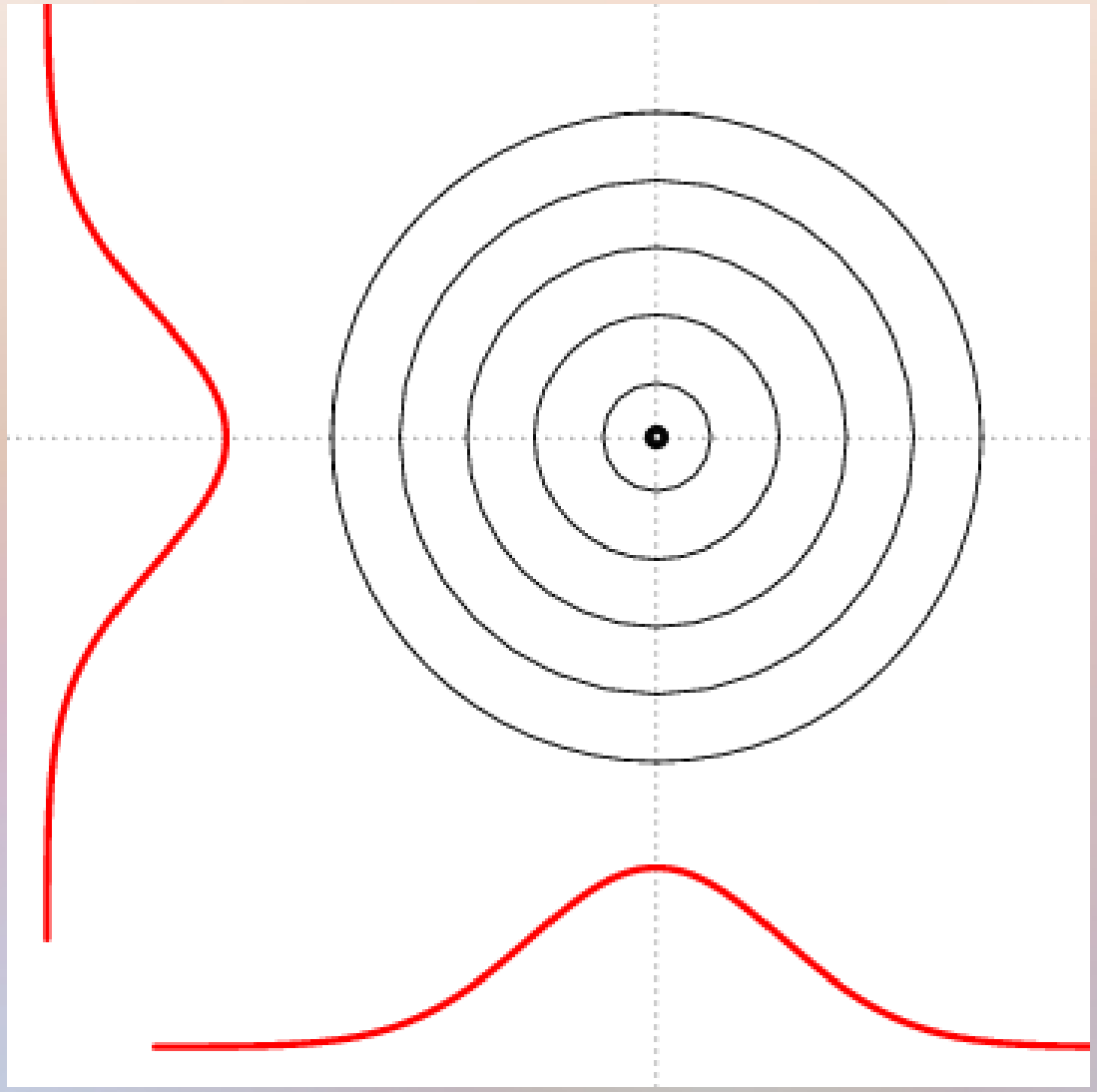
Bull’s Eye- Precise and Accurate



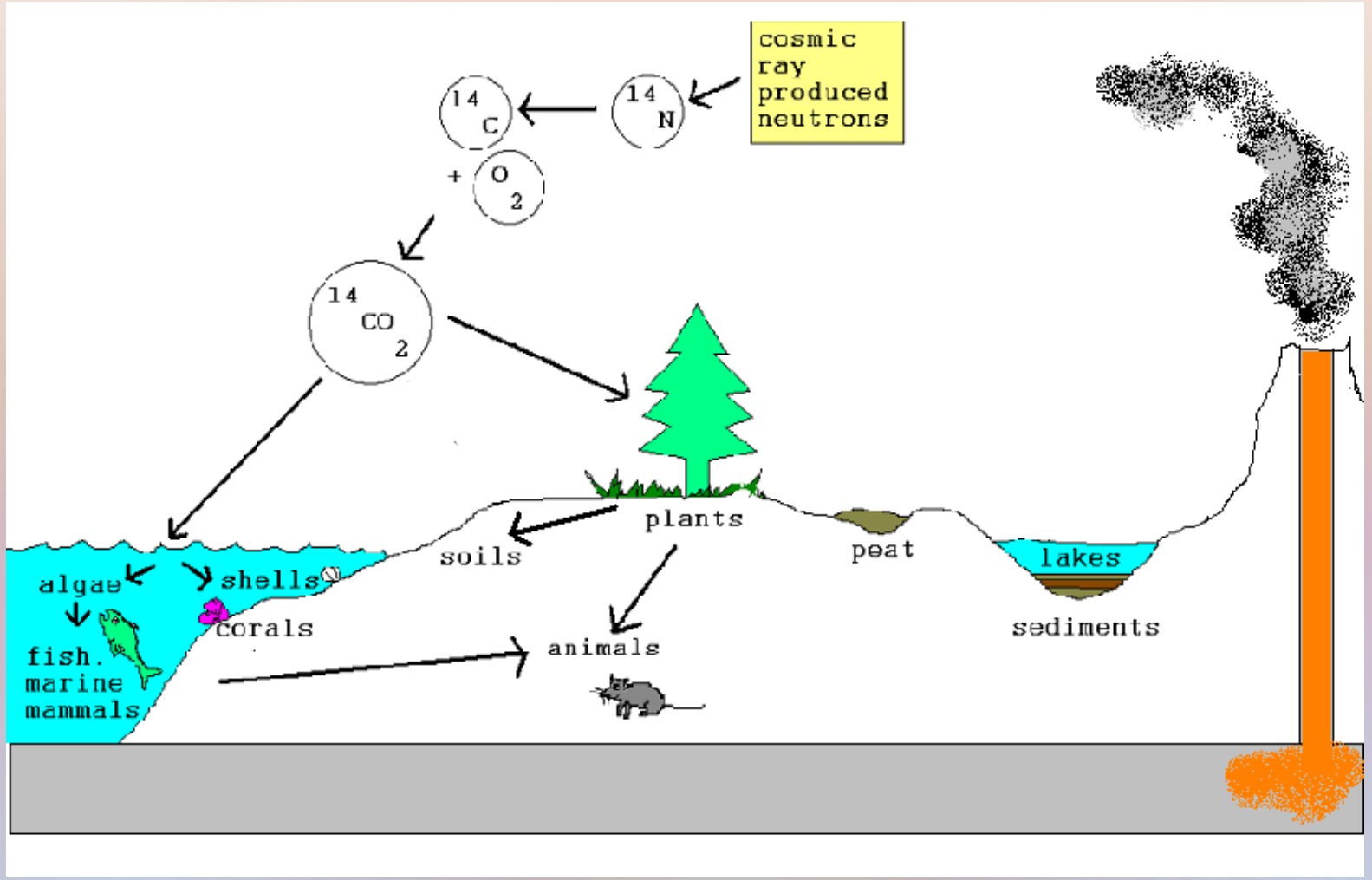
Precise but inaccurate



Accurate (on average) but imprecise

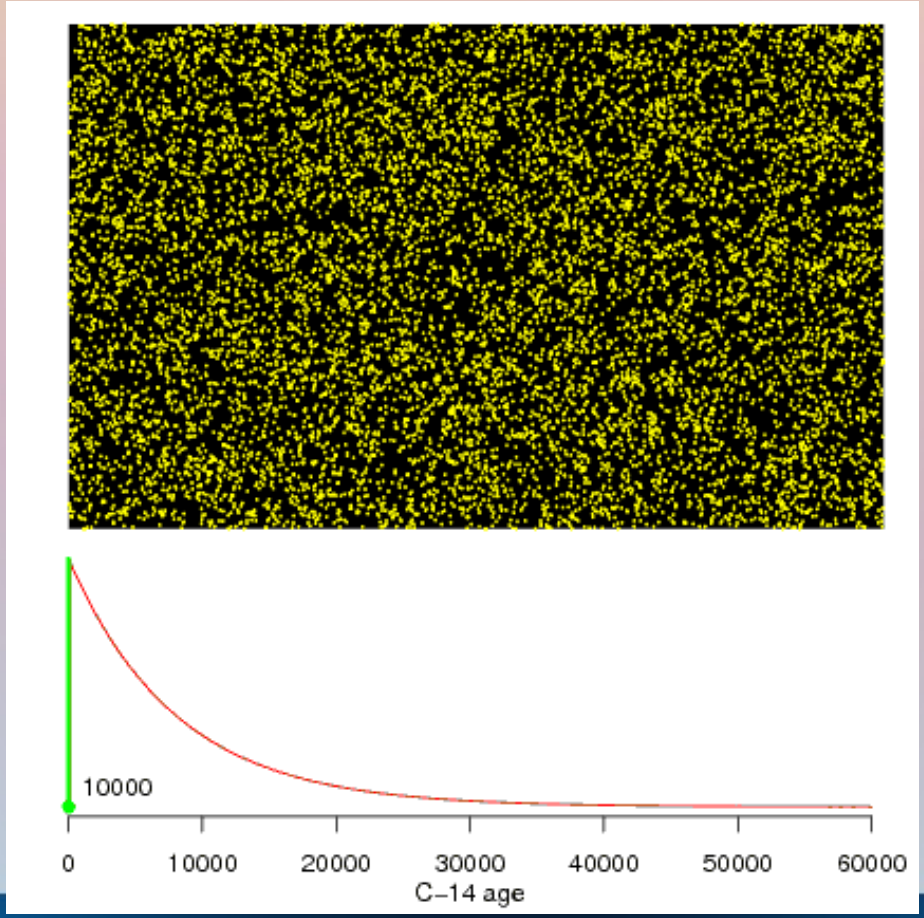


Carbon dating

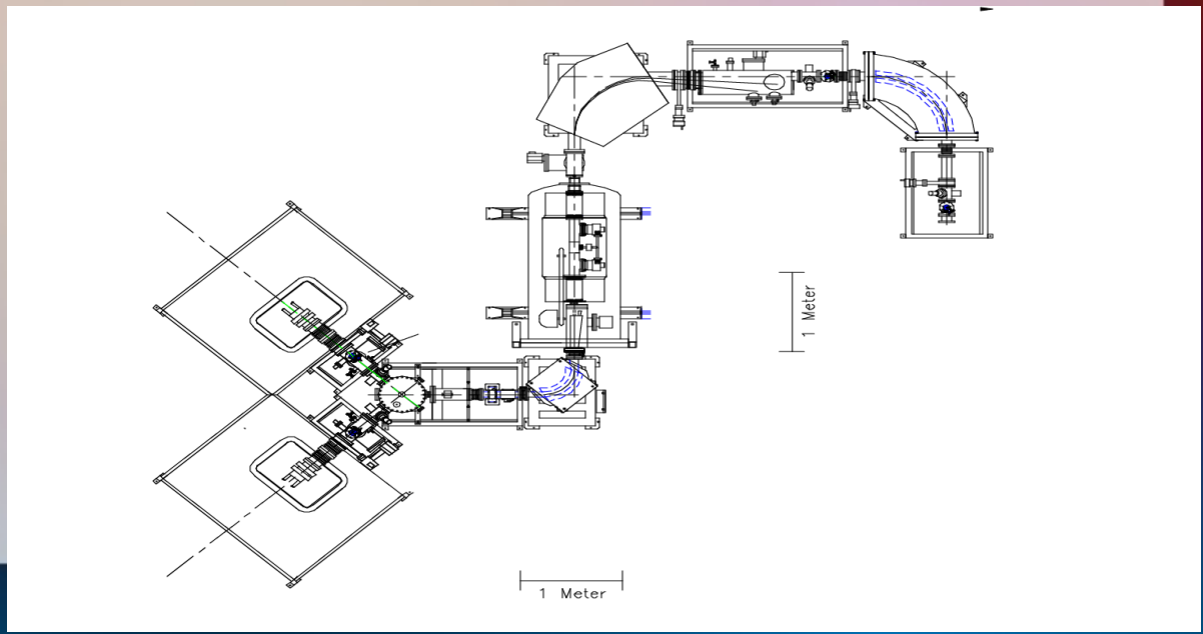


^{14}C dating

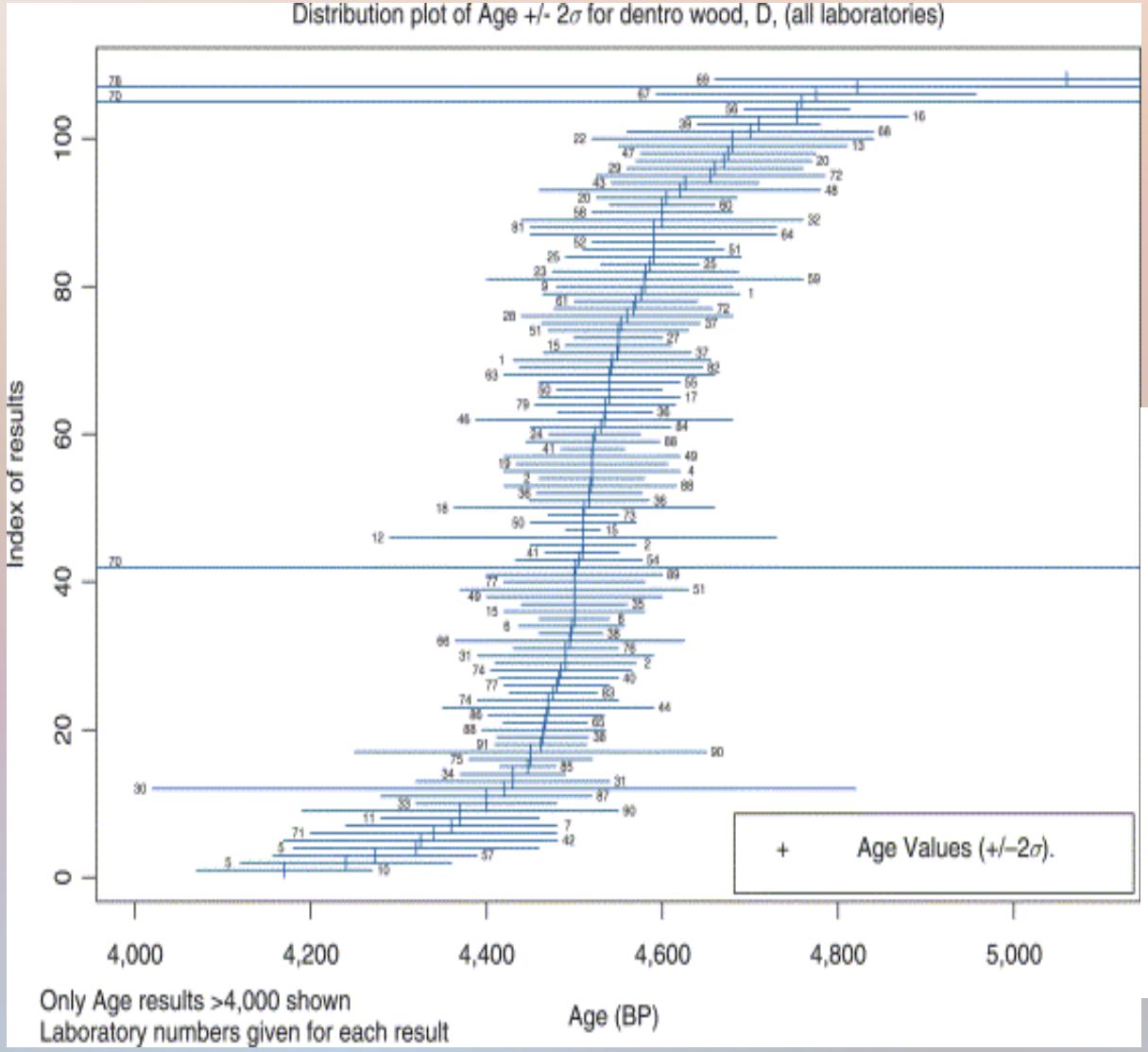
- ^{14}C unstable, half-life 5568 yr
- Ratio $^{14}C/C$ gives age fossil

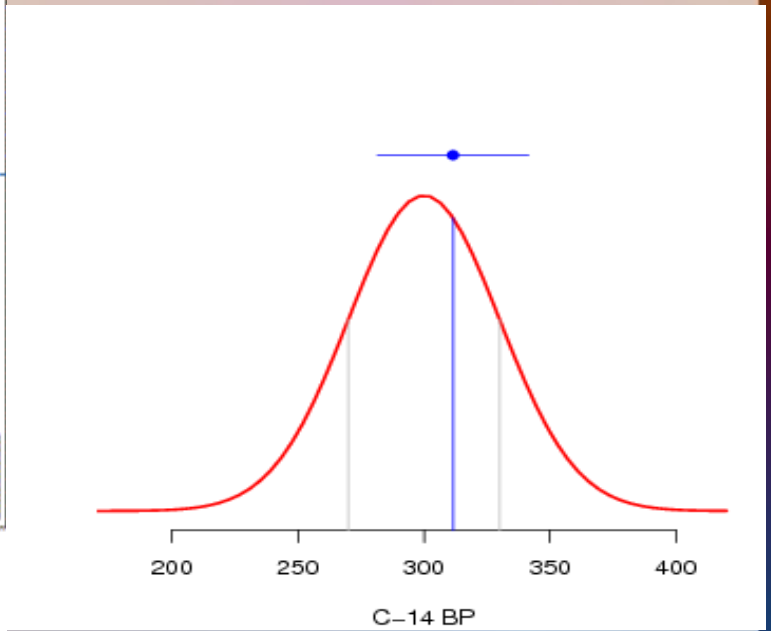


- Atm. ^{12}C (99%), ^{13}C (1%), **^{14}C (10^{-12})**
- ^{14}C decays exponentially with time
- Cease metabolism → clock starts ticking
- Measure ratio $^{14}C/C$ to estimate age fossil

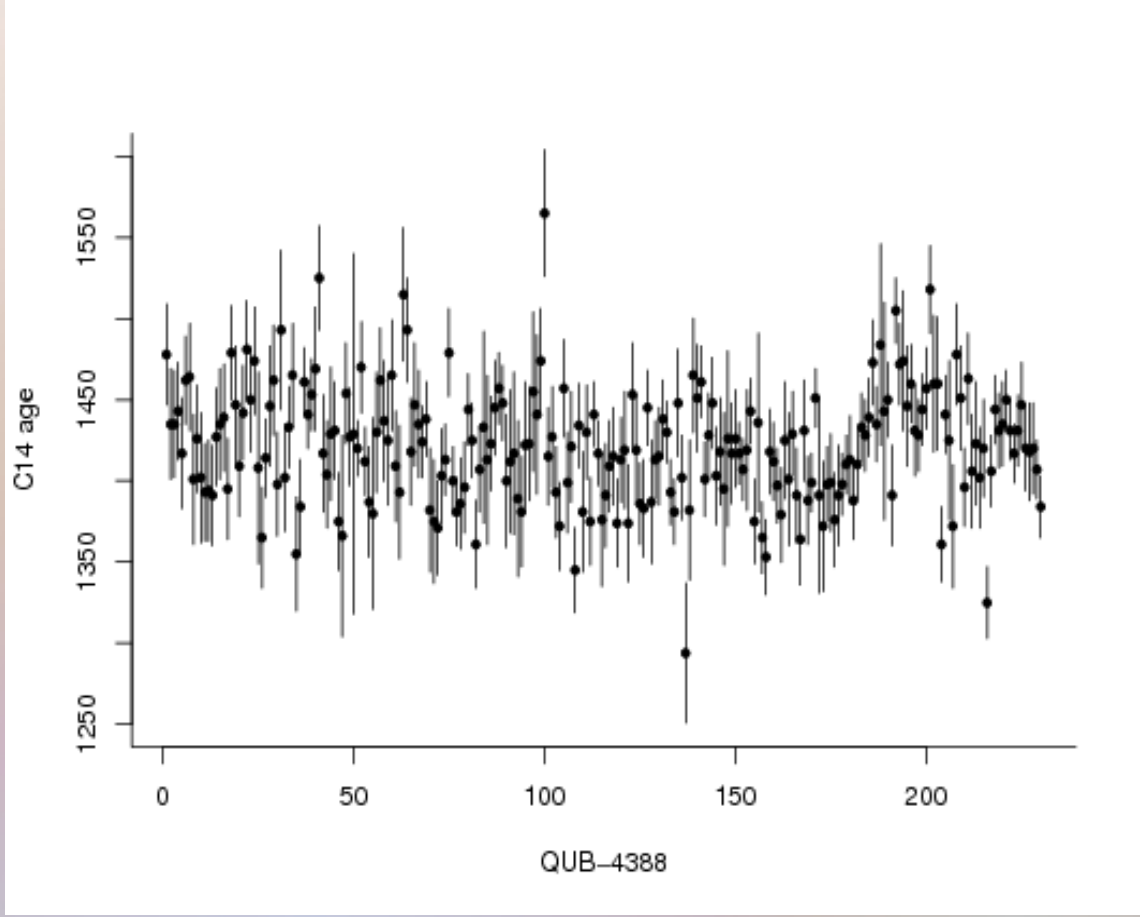


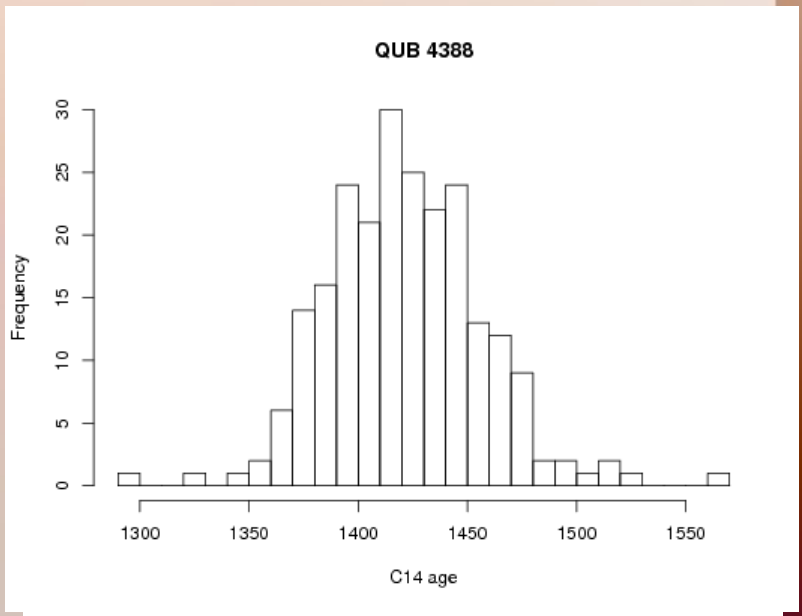
Dating uncertainties

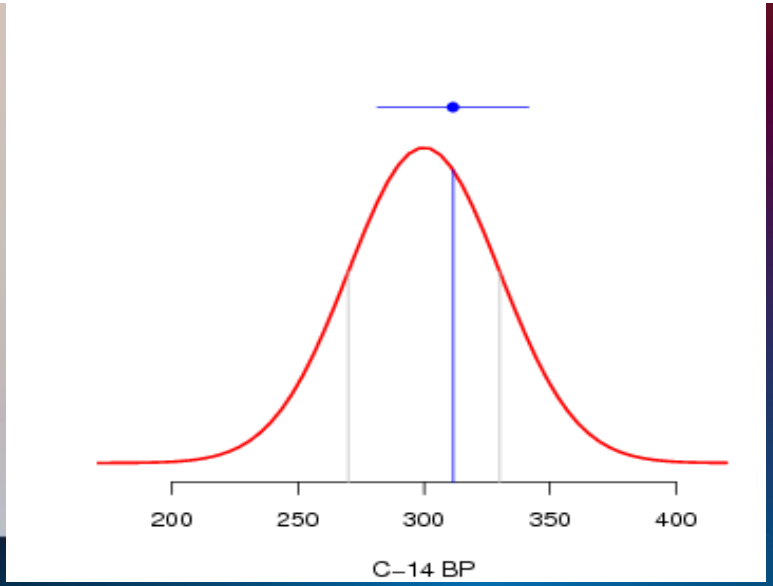


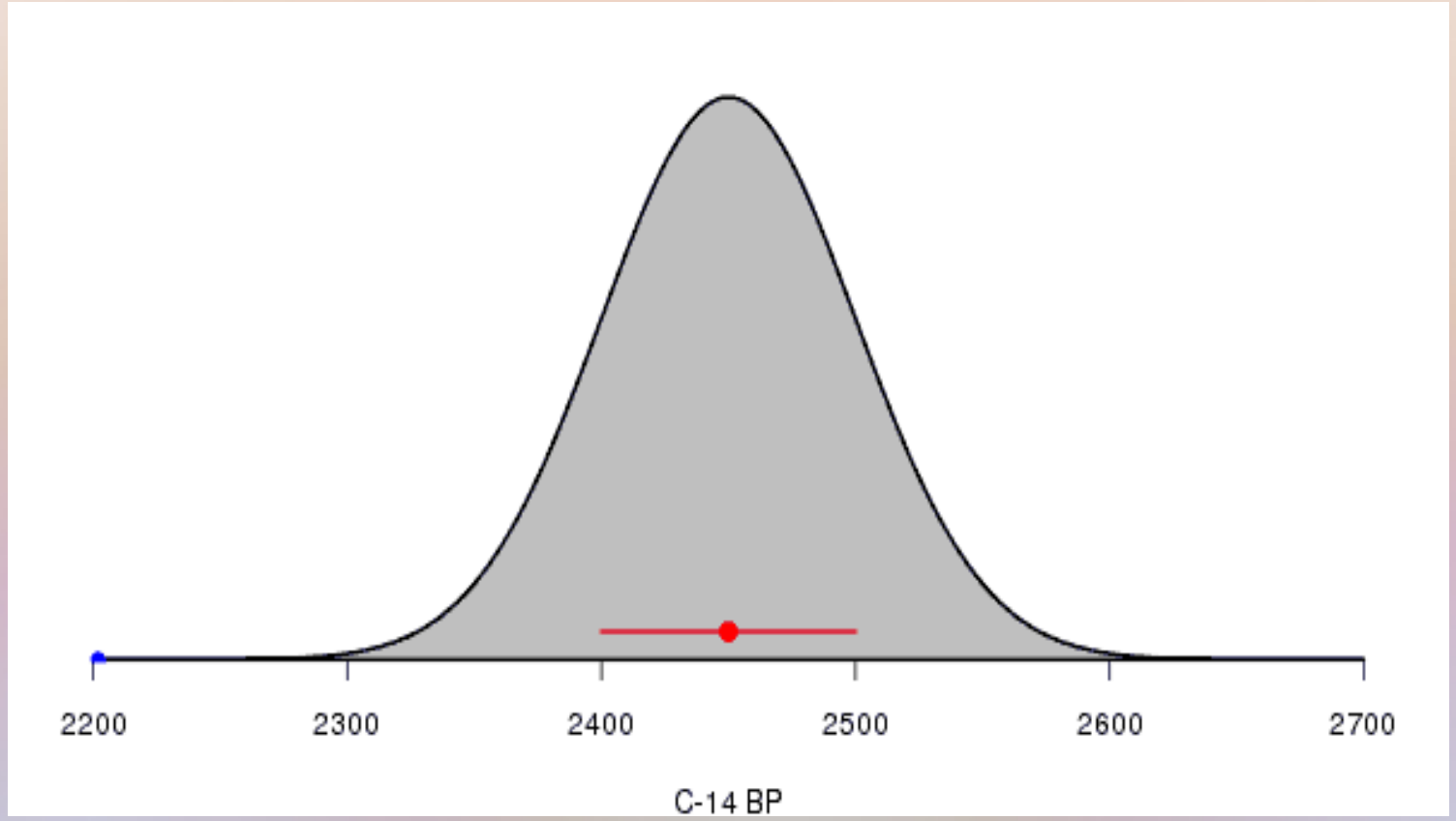


^{14}C dating


C14 age
1250
1350
1450
1550
0
50
100
150
200
QUB–4388


QUB 4388
Frequency
0
5
10
15
20
25
30
1300
1350
1400
1450
1500
1550
C14 age


200
250
300
350
400
C–14 BP


2200
2300
2400
2500
2600
2700
C-14 BP

An alternative to the normal model

- Christen and Perez 2009, Radiocarbon
- Spread of dates often beyond expected
- Reported errors are *estimates*
- Propose an error multiplier, gamma
- No more need for outlier modelling?

Tree-ring coverage for IntCal04: until 12.4 kcal BP

Irish Oak

Waikato

German Oak

Groningen

German Oak

Pretoria

German Oak

German Pine

Swiss Pine

Heidelberg

Irish Oak

German Oak

Belfast

PNW/CA

German Oak

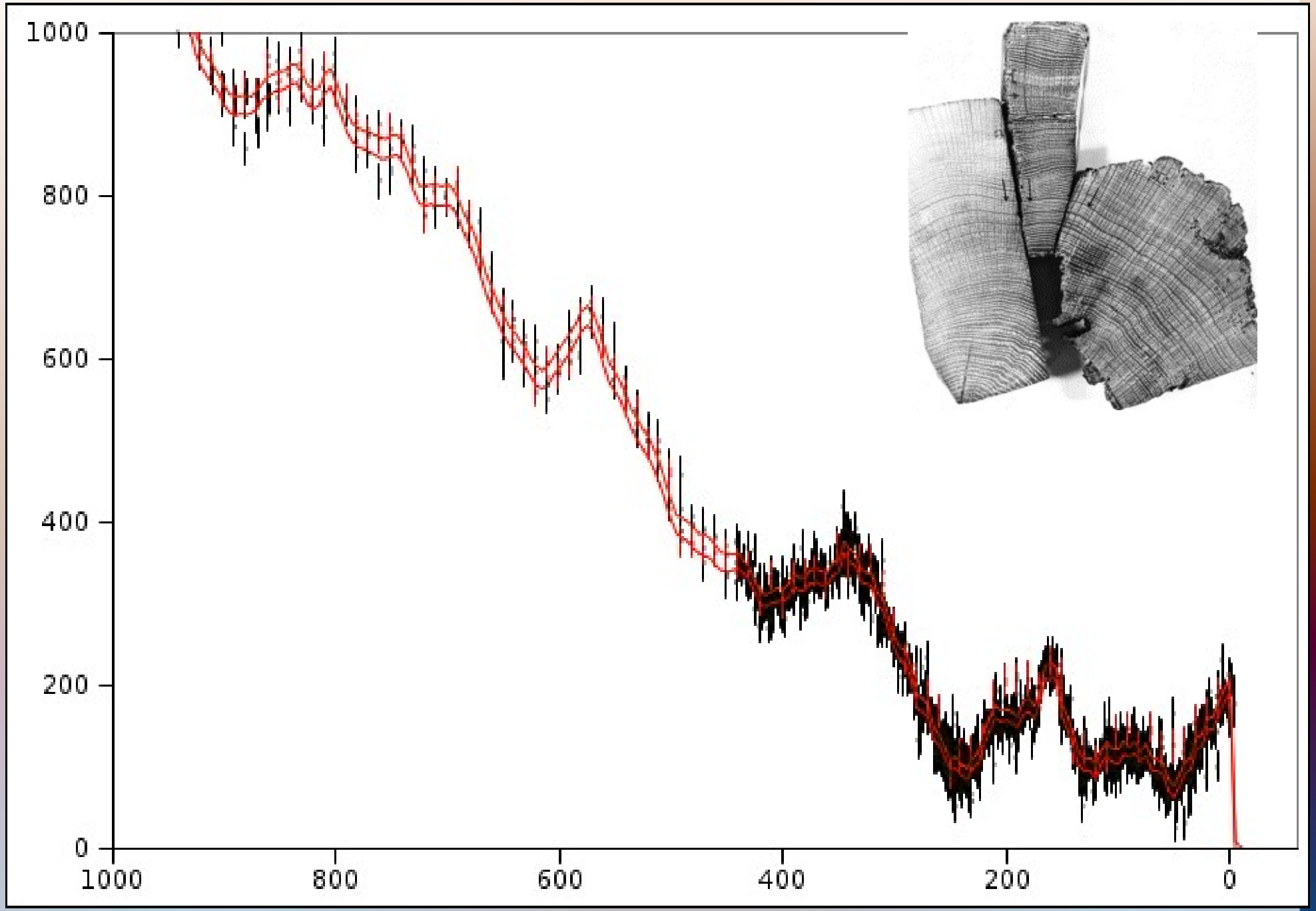
German Pine

Seattle

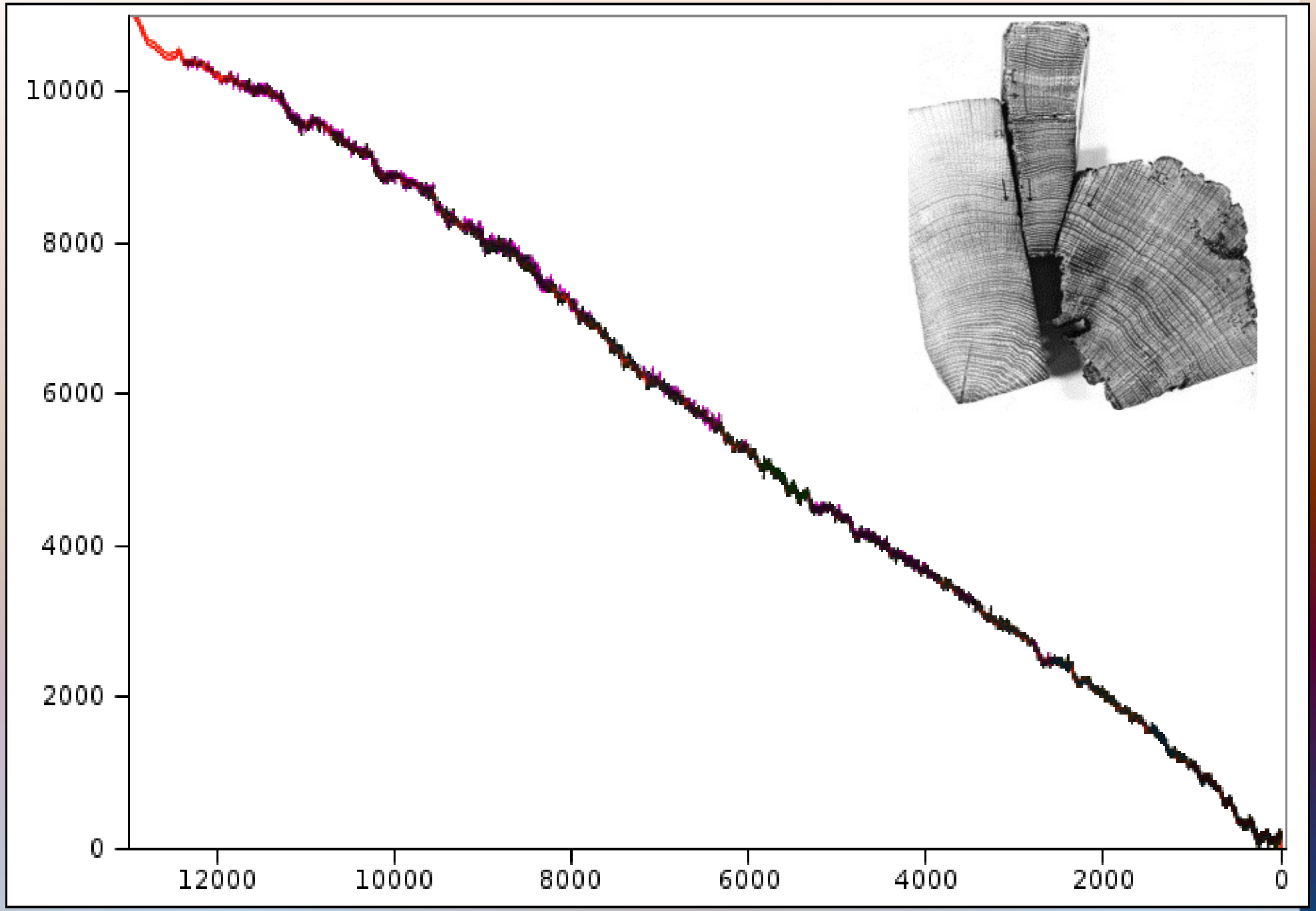
0 2000 4000 6000 8000 10000 12000 14000

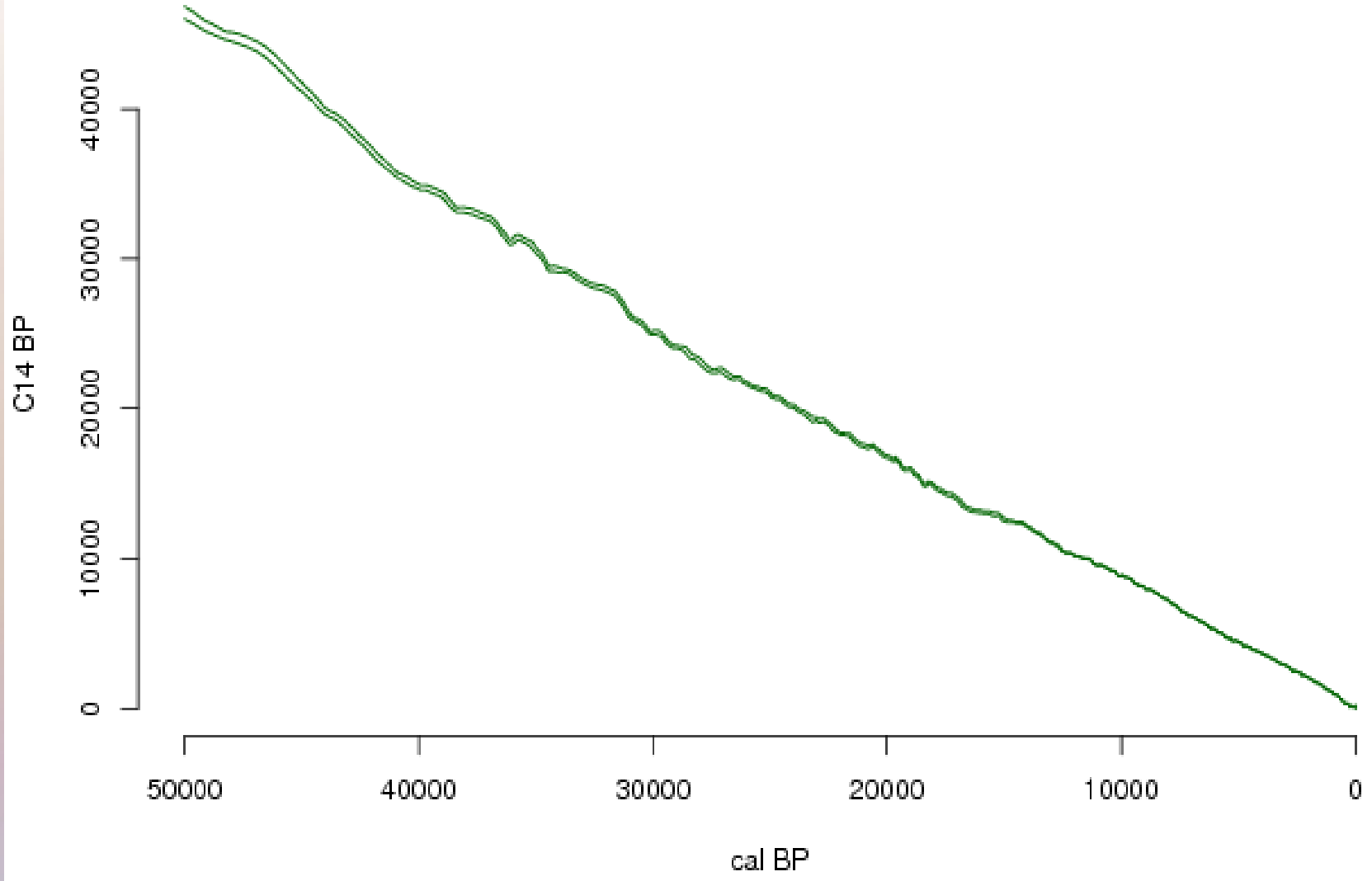
cal BP

Tree-ring coverage for IntCal04

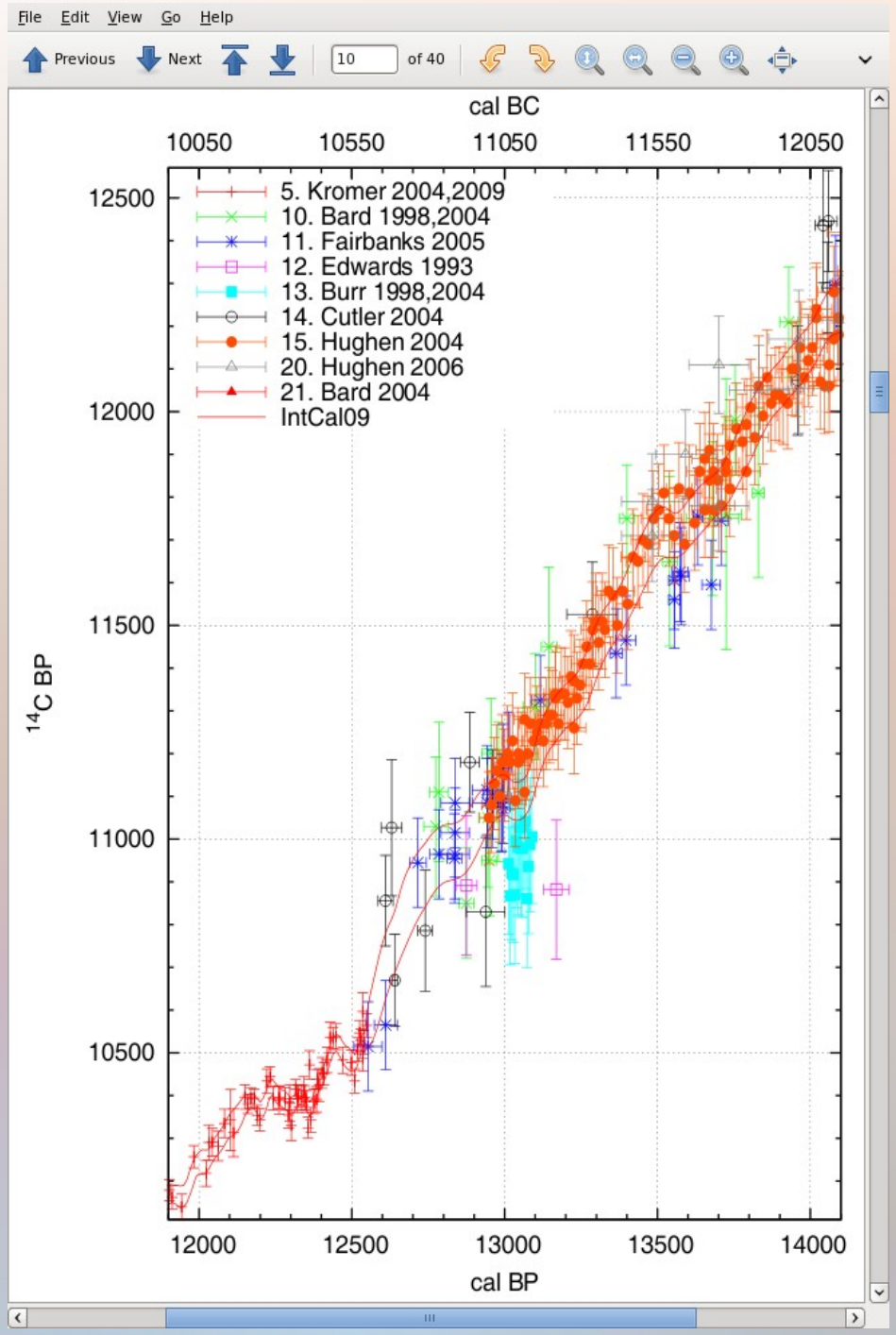


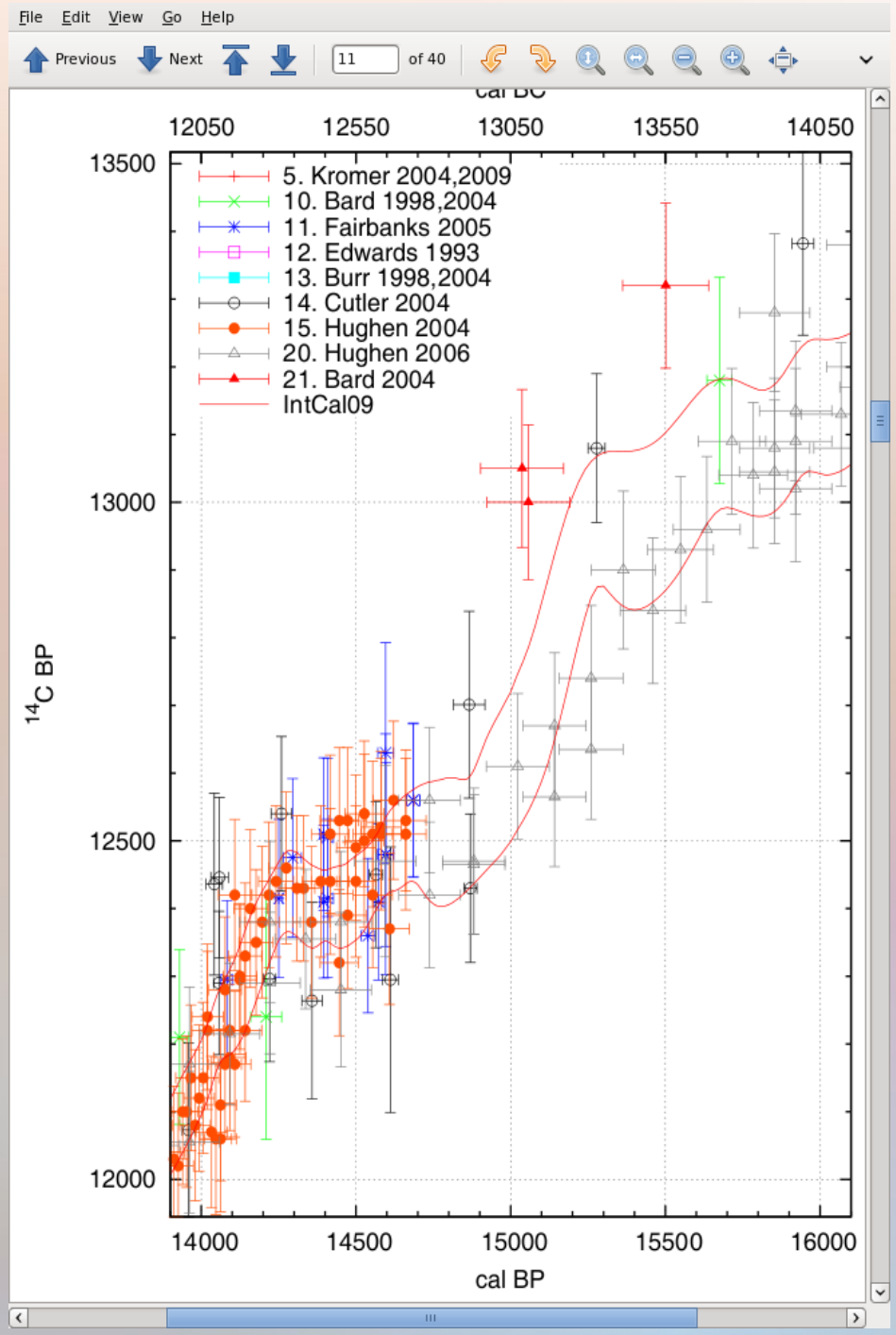
Tree-ring coverage for IntCal09





Reimer et al., 2009. IntCal09 and marine09 radiocarbon age calibration curves, 0–50,000 years cal BP. Radiocarbon 51


File Edit View Go Help
Previous
Next
10
of 40
cal BC
10050
10550
11050
11550
12050
12500
12000
11500
11000
10500
5. Kromer 2004,2009
10. Bard 1998,2004
11. Fairbanks 2005
12. Edwards 1993
13. Burr 1998,2004
14. Cutler 2004
15. Hughen 2004
20. Hughen 2006
21. Bard 2004
IntCal09
14C BP
12000
12500
13000
13500
14000
cal BP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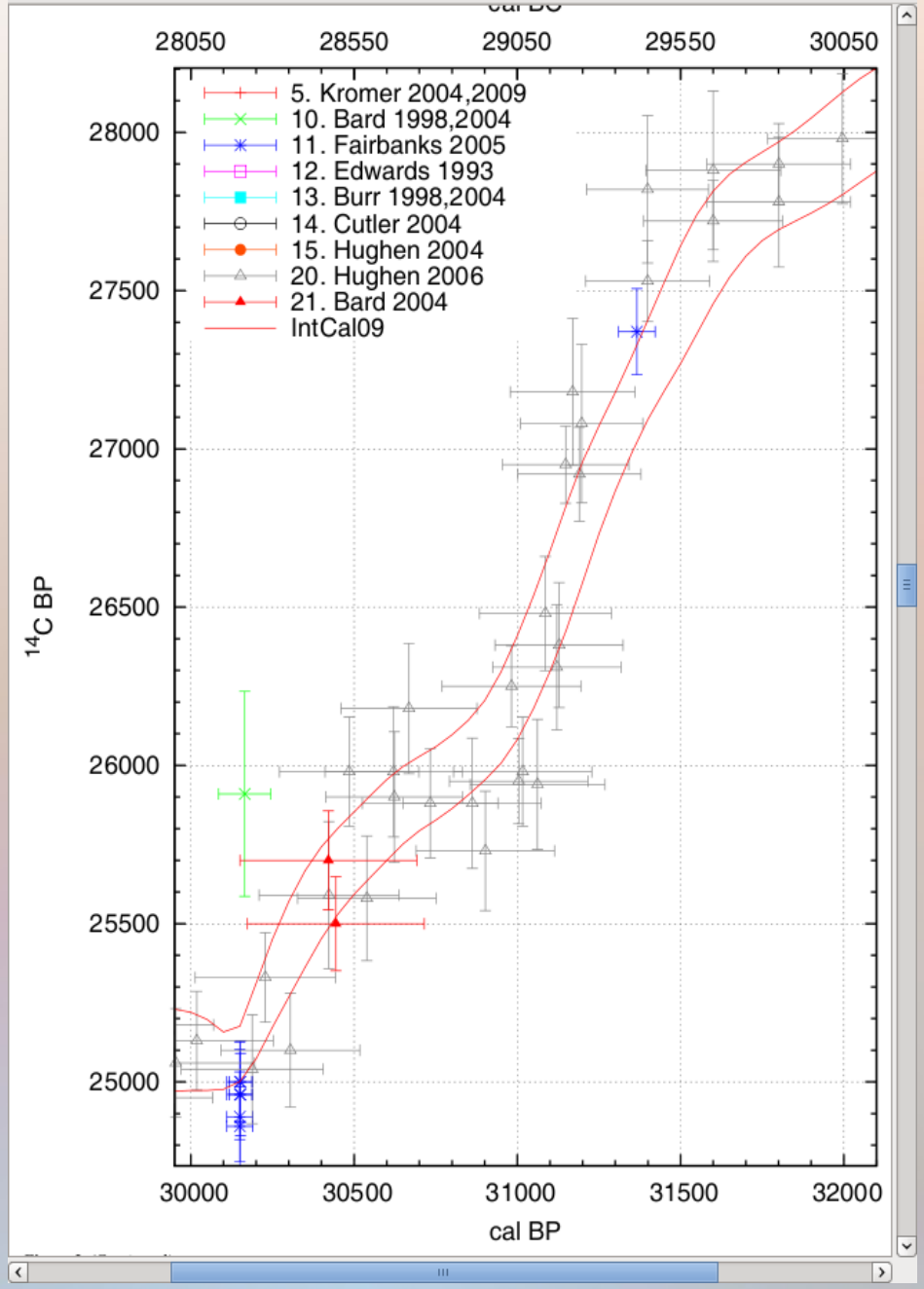
Previous
Next
11
of 40
12050
12550
13050
13550
14050
13500
13000
12500
12000
5. Kromer 2004,2009
10. Bard 1998,2004
11. Fairbanks 2005
12. Edwards 1993
13. Burr 1998,2004
14. Cutler 2004
15. Hughen 2004
20. Hughen 2006
21. Bard 2004
IntCal09
14C BP
14000
14500
15000
15500
16000
cal BP

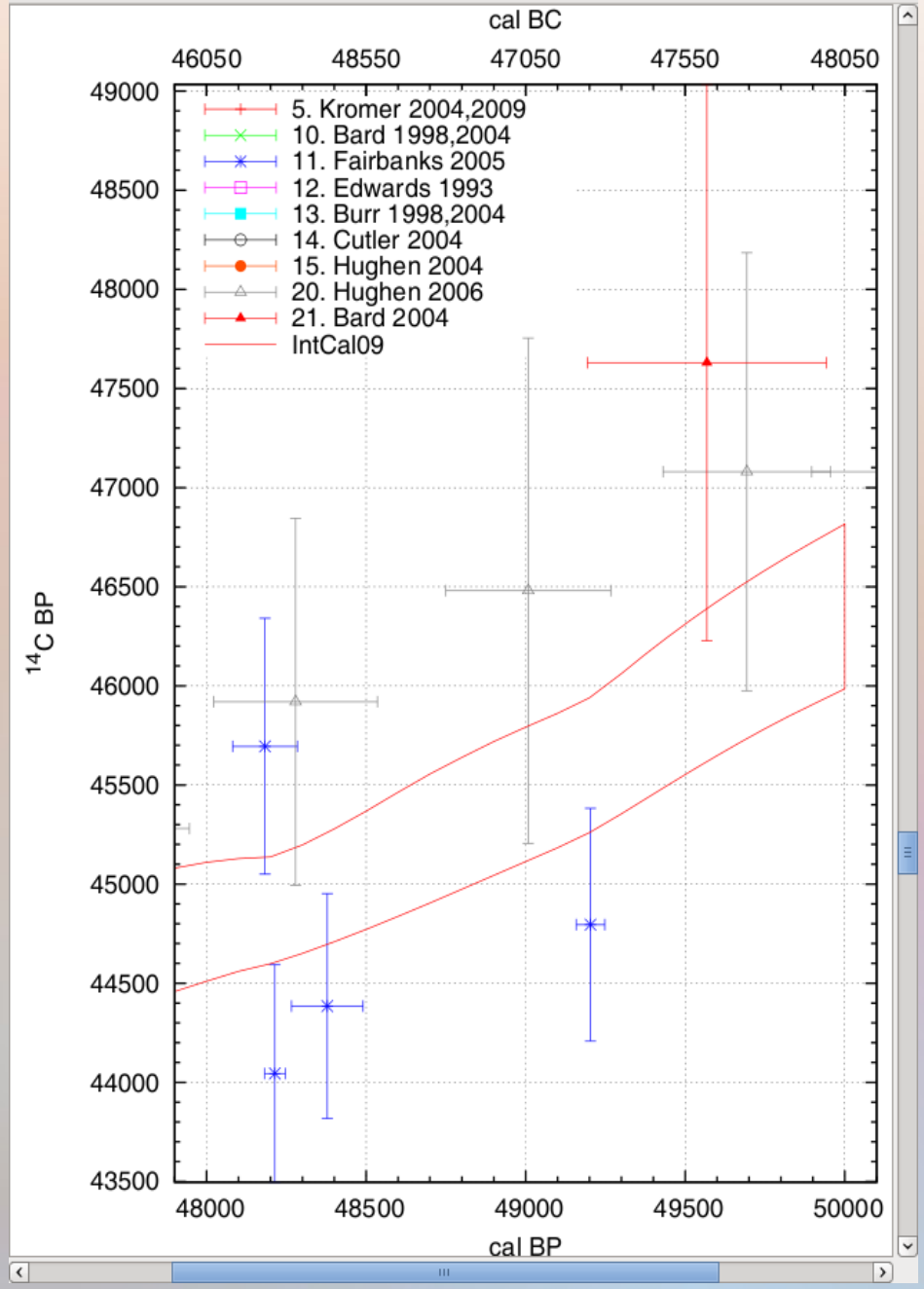
File Edit View Go Help

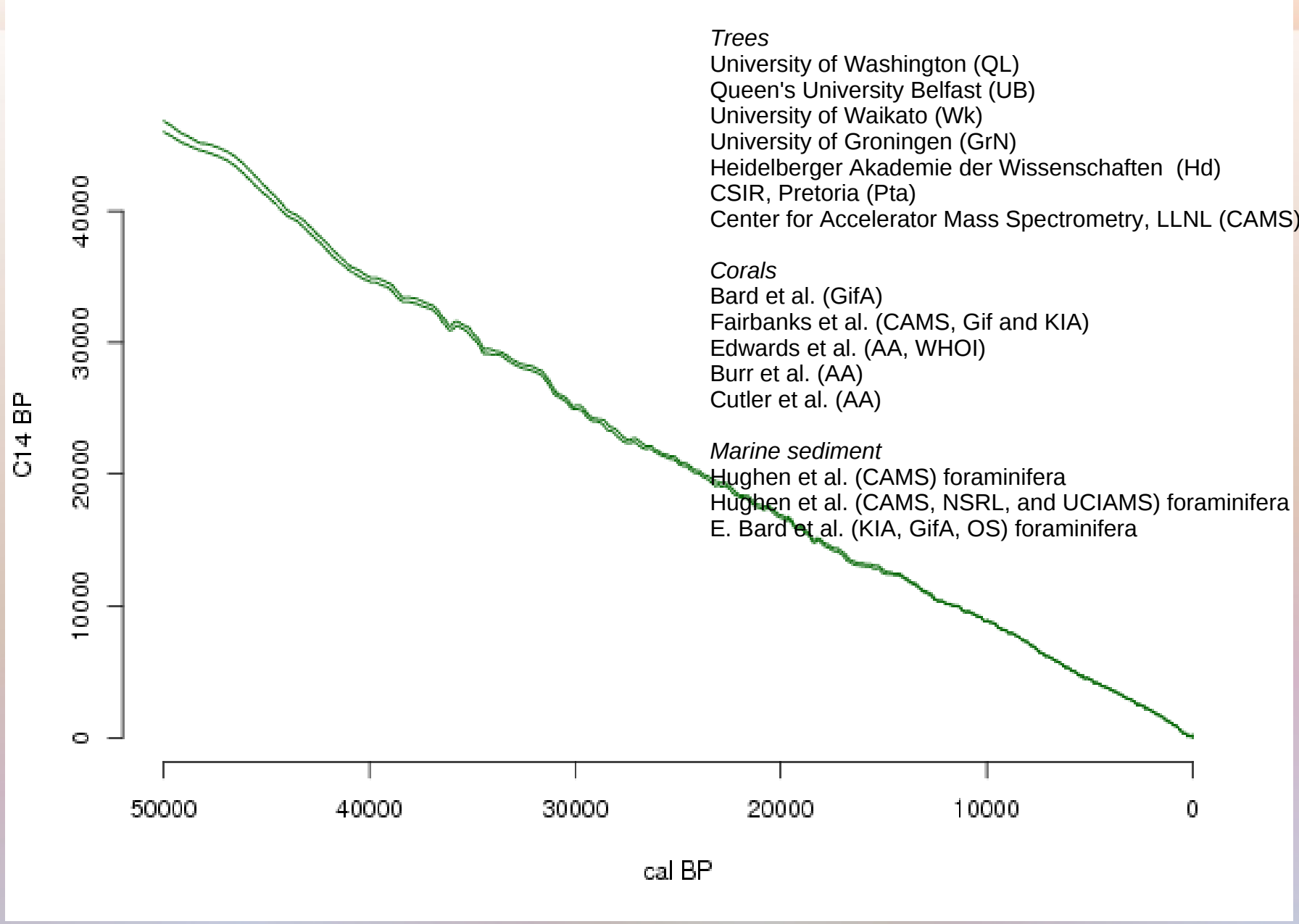
Previous Next 19 of 40



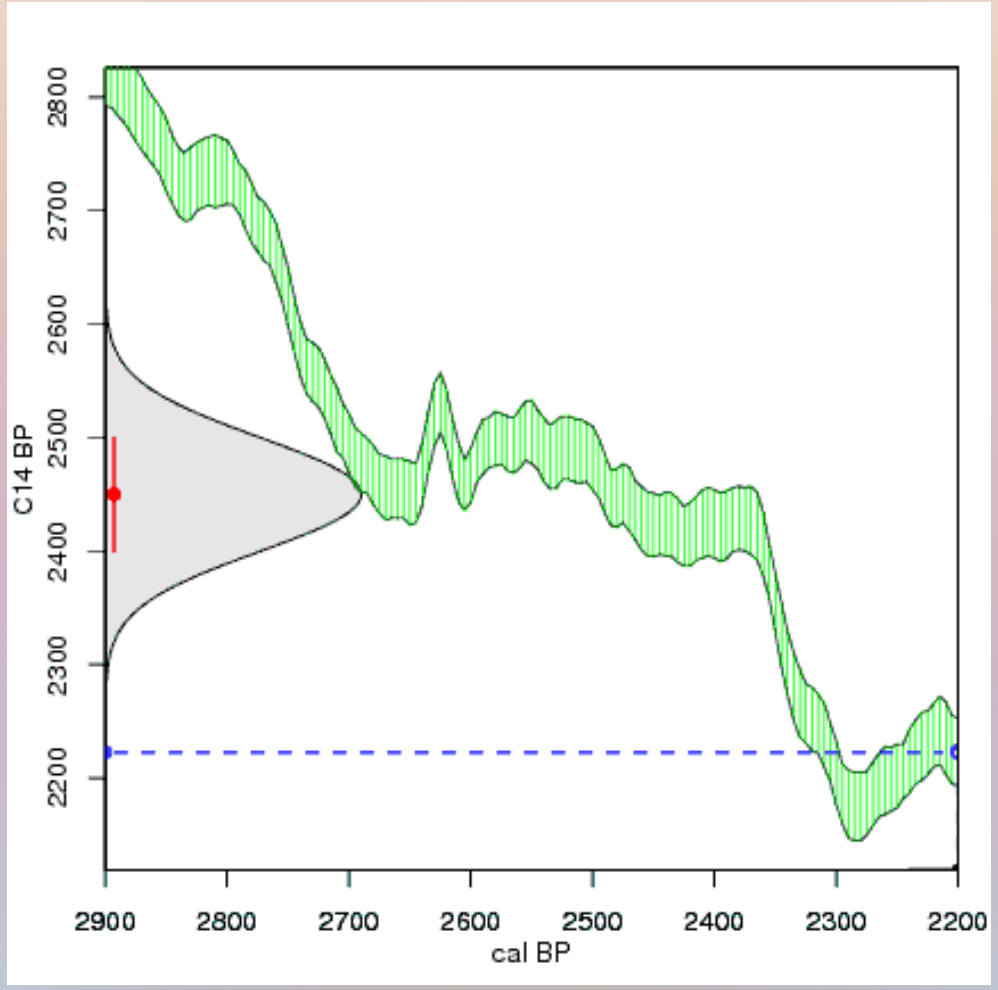
File Edit View Go Help

Previous Next 28 of 40



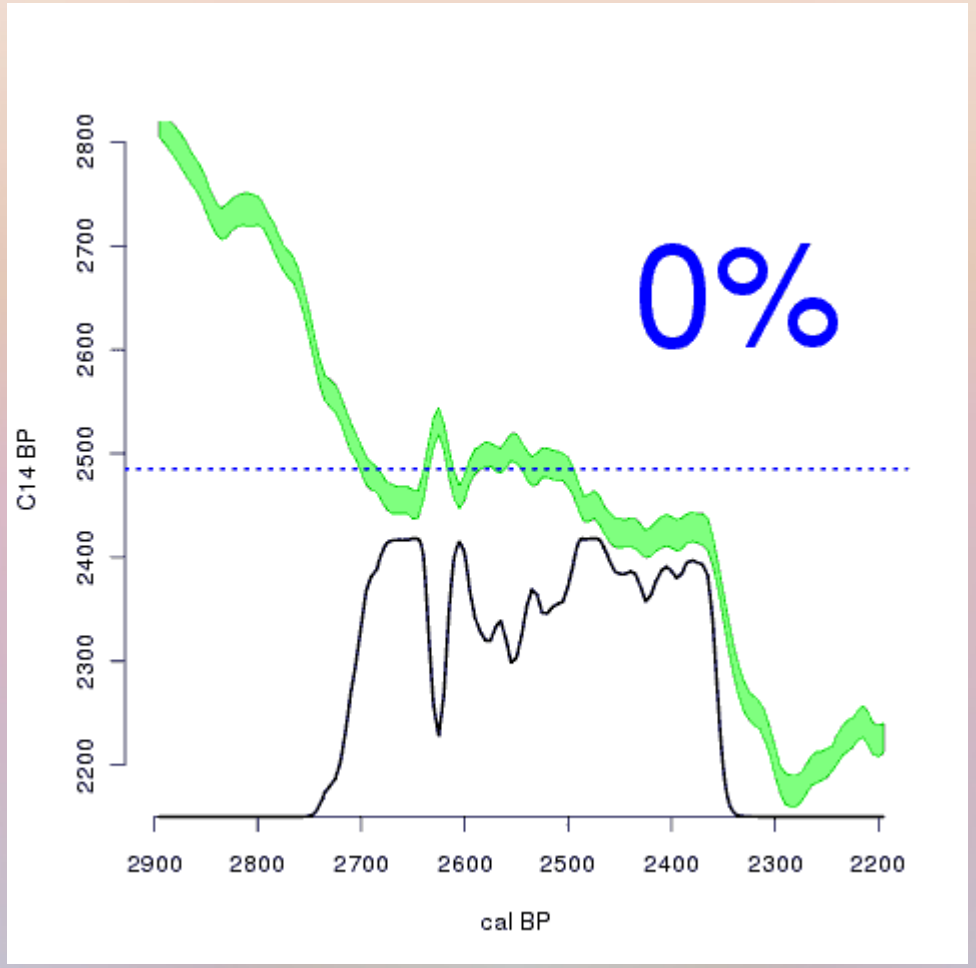


Reimer et al., 2009. IntCal09 and marine09 radiocarbon age calibration curves, 0–50,000 years cal BP. Radiocarbon 51

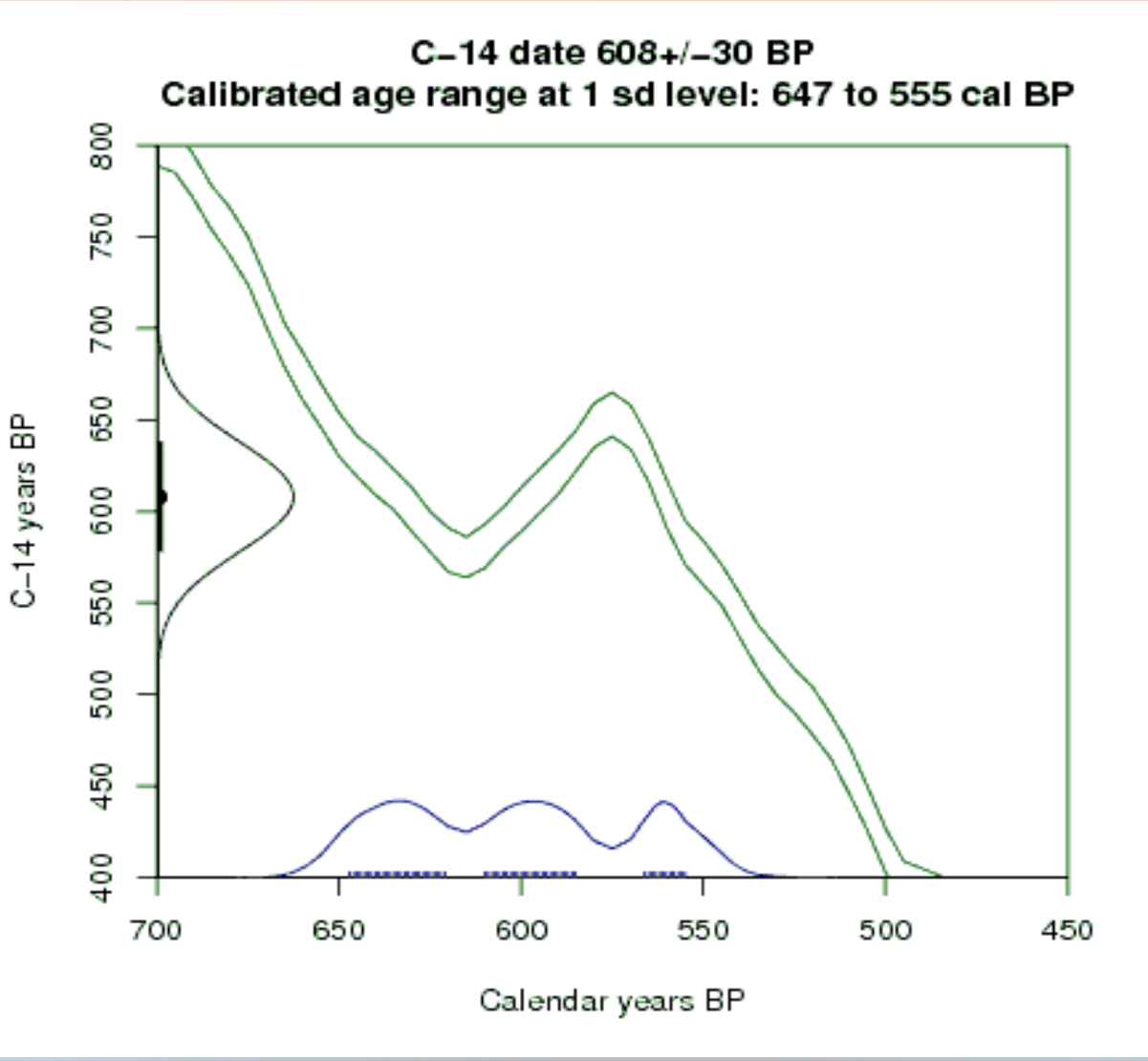


http:///www.chrono.qub.ac.uk/blaauw/

^{14}C calibration



^{14}C dating


C–14 date 608+/–30 BP
Calibrated age range at 1 sd level: 647 to 555 cal BP
C–14 years BP
800
750
700
650
600
550
500
450
400
700
650
600
550
500
450
Calendar years BP

Calibrate - methods

- Probability preferred over intercept
  - Less sensible to small changes in mean
  - Resulting cal.ranges make more sense
- Procedure probability method:
  - What is prob. of cal.year *x*, given the date?
  - Calculate this prob. for all cal.ages

Combine errors date and cal.curve $\sqrt{(\sigma^2+sd^2)}$

Calibrate - methods

- Multimodal distributions
  - Which of the peaks most likely (Calib %)?
  - How report date?
    - 1 or 2 sd
    - sd range
    - mean±sd
    - mode
    - weighted mean (Telford et al. ‘05 Holocene)
    - why not plot the entire distribution!

Calibrate - DIY

- Using eyes/hands on handout paper
  - Imagine invisible arbitrary second axes for probs
  - Don't use intercept
  - Try “cosmic schwung”, not mm precision
  - Don’t go from C14 to calBP! What is prob *x* cal BP?
  - Calibrated ranges?