Geologic Limitations

Conventional strategies for dealing with complexities
Power of large-n

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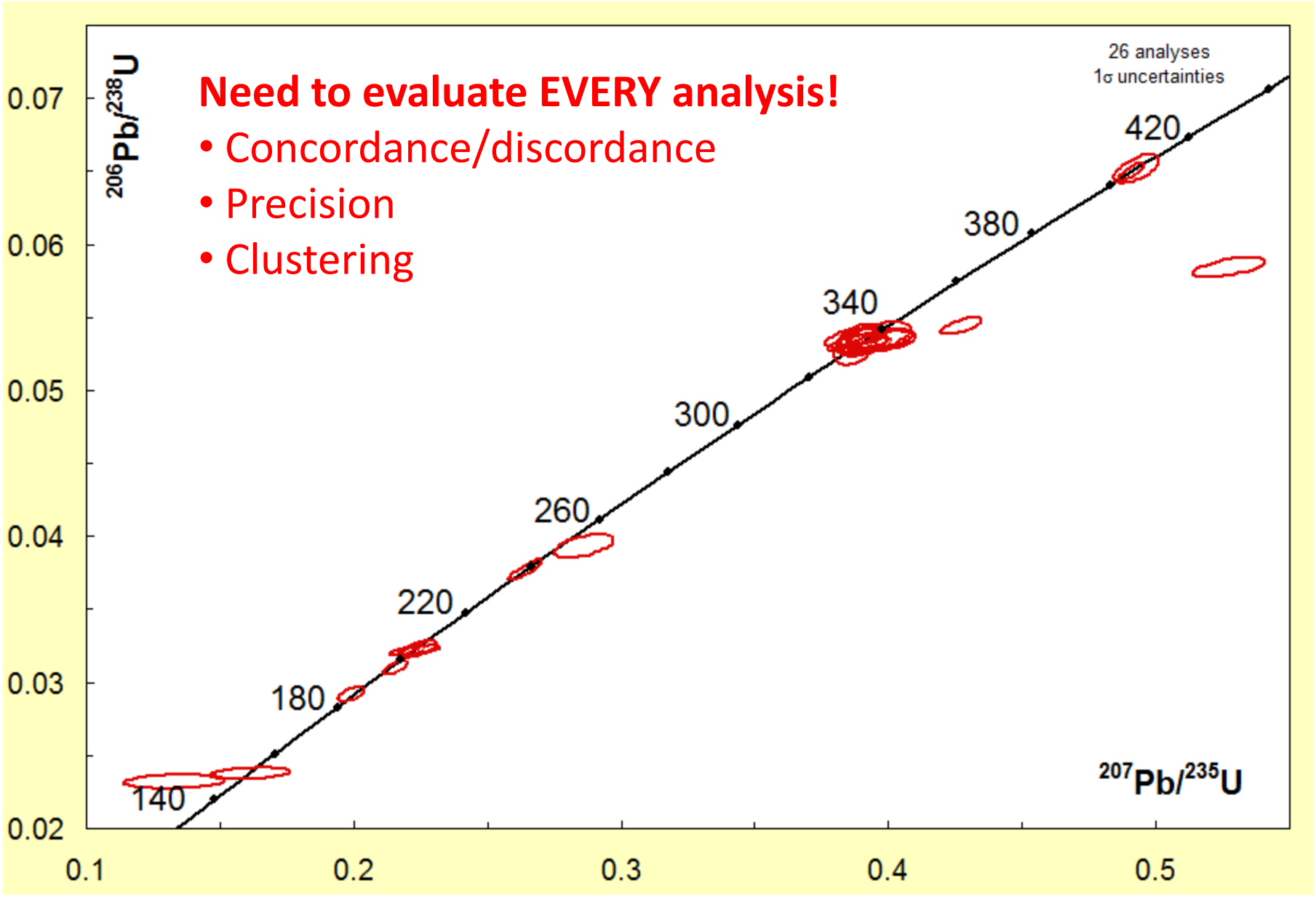
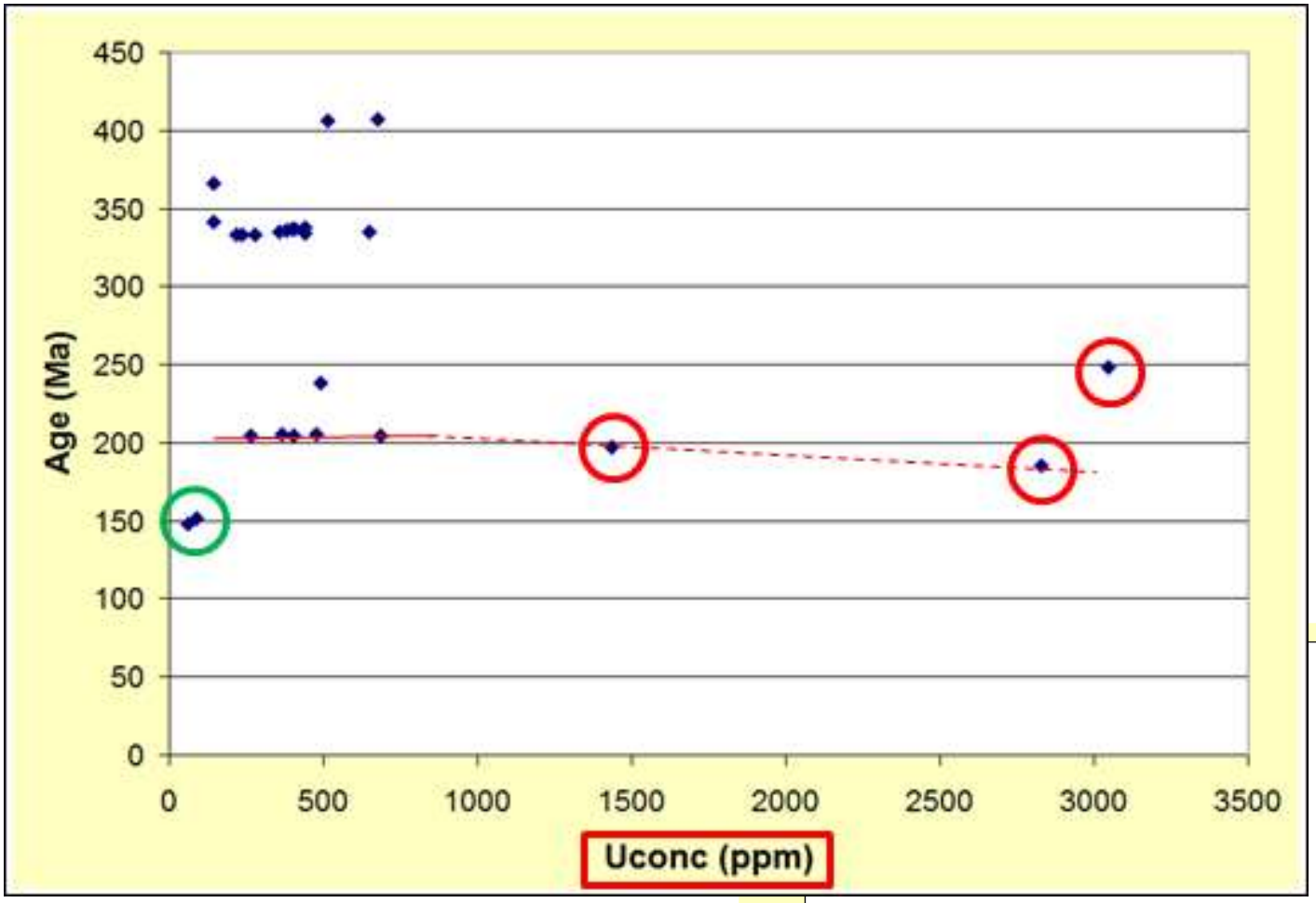
Department of Geosciences
University of Arizona

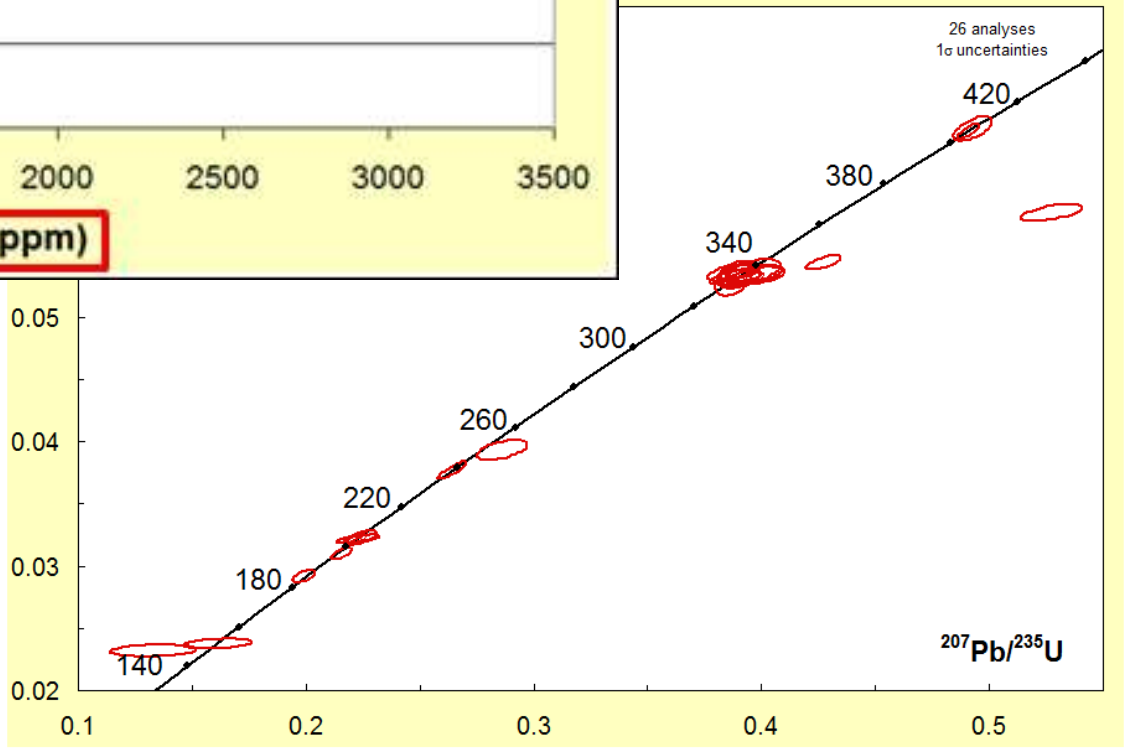
A young example…..

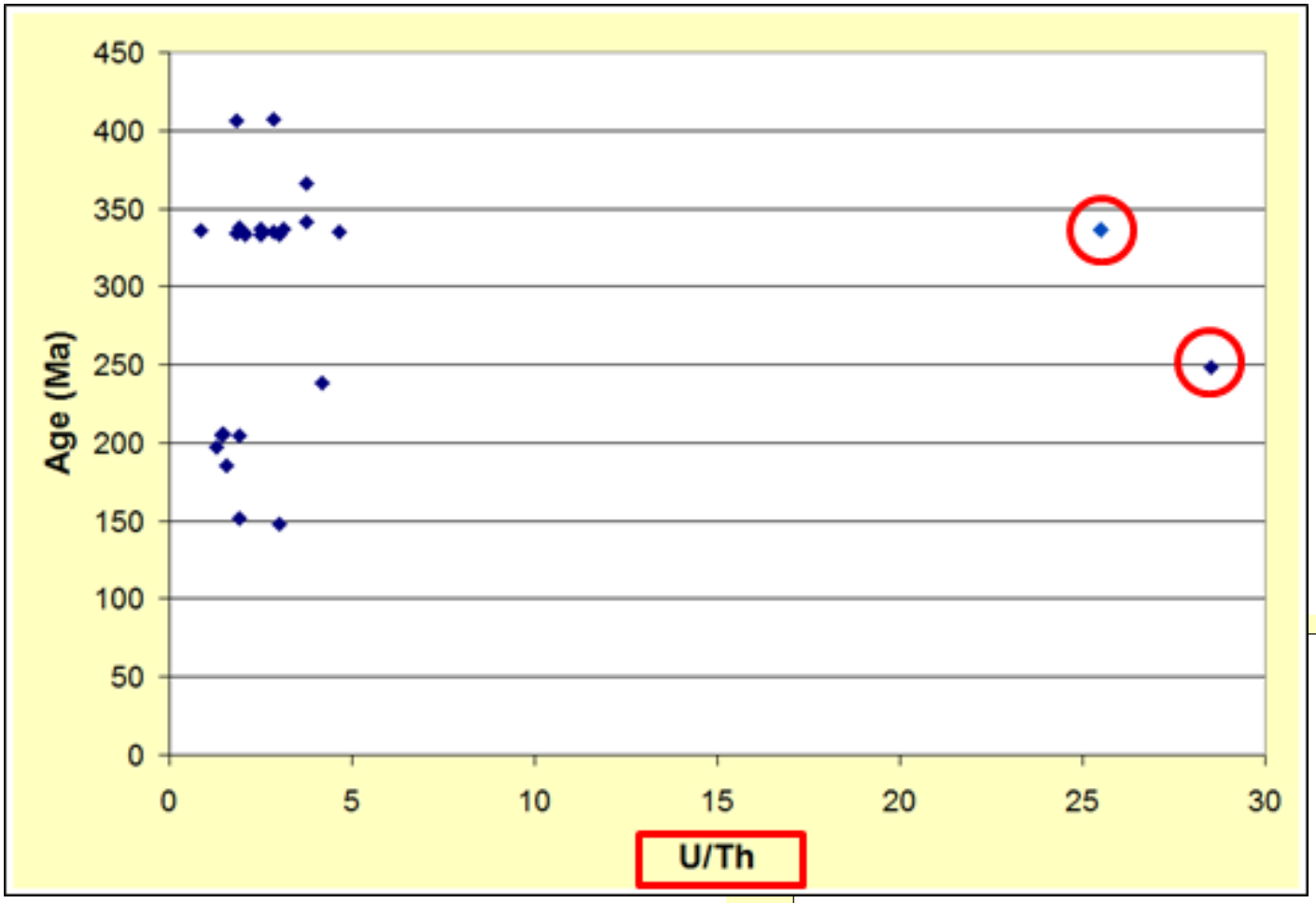




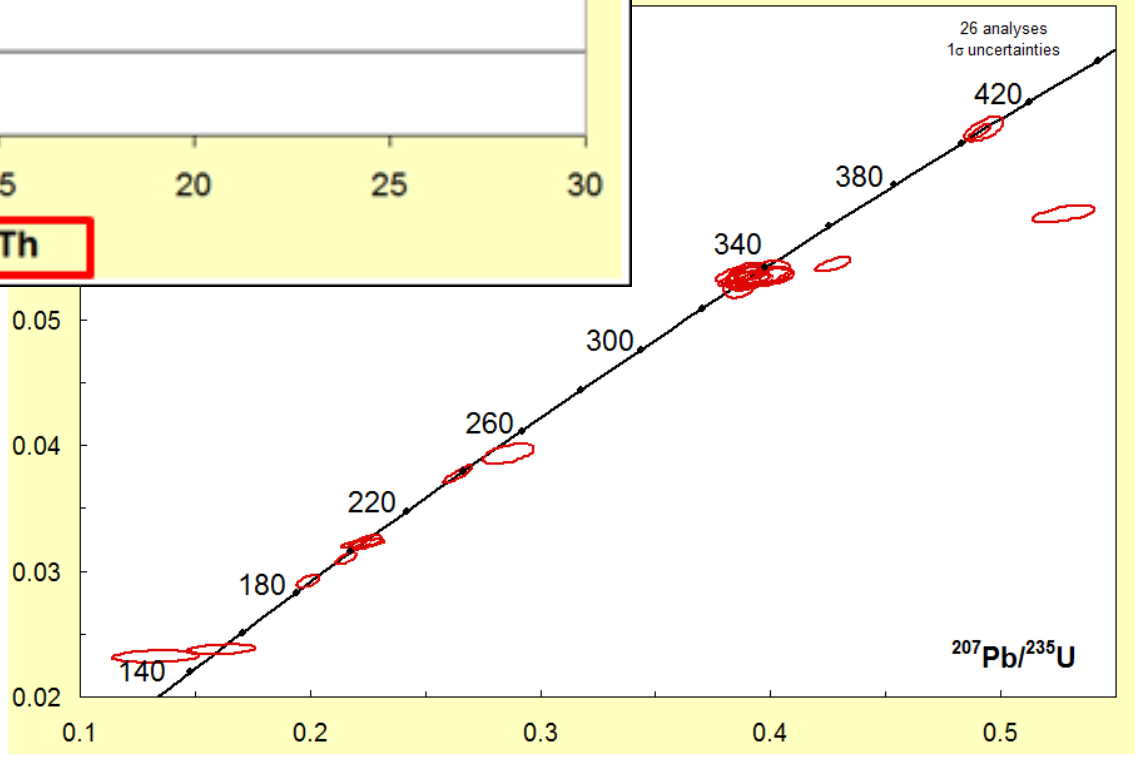
Uconc:

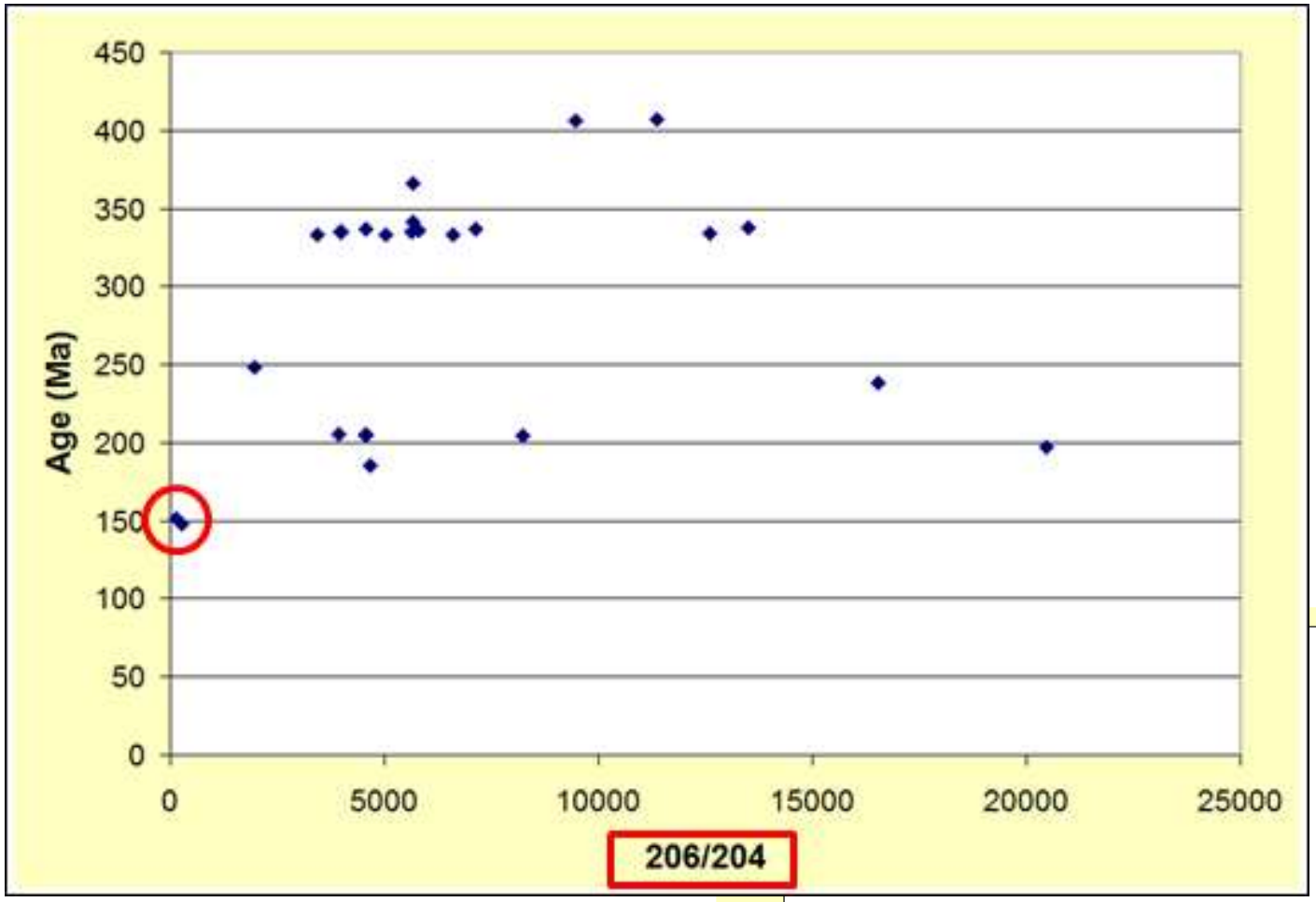
- Pb loss?
- Non-zircon?



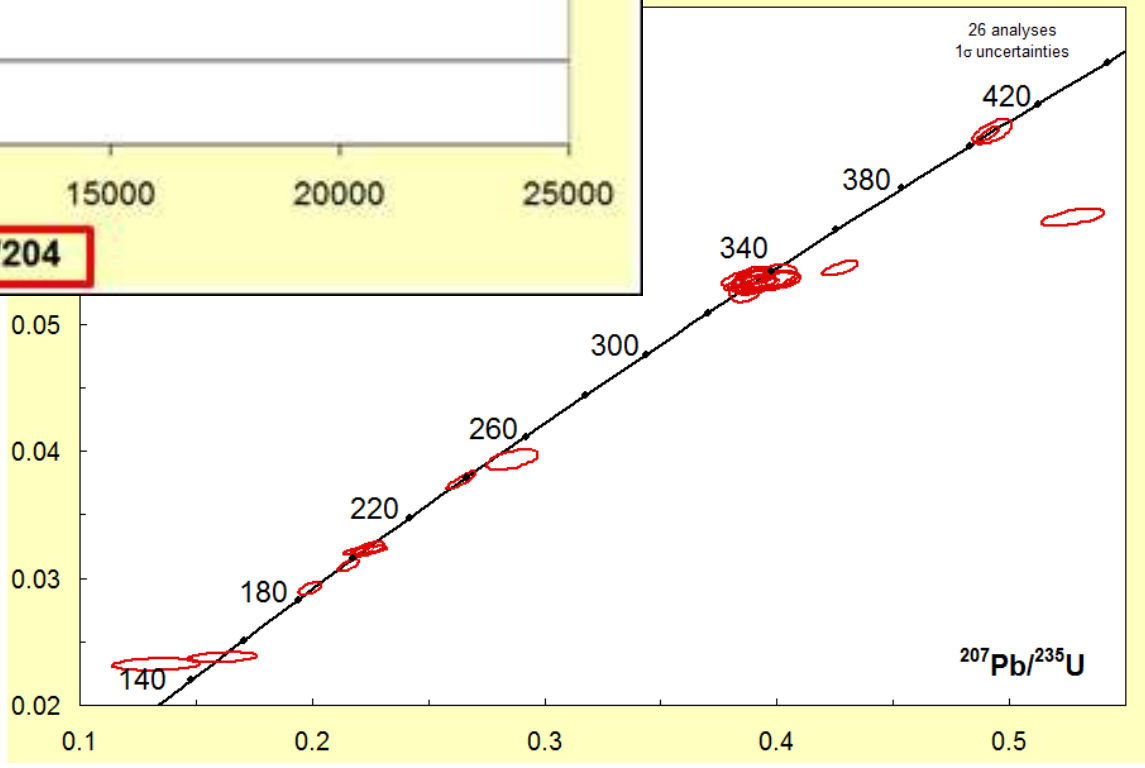


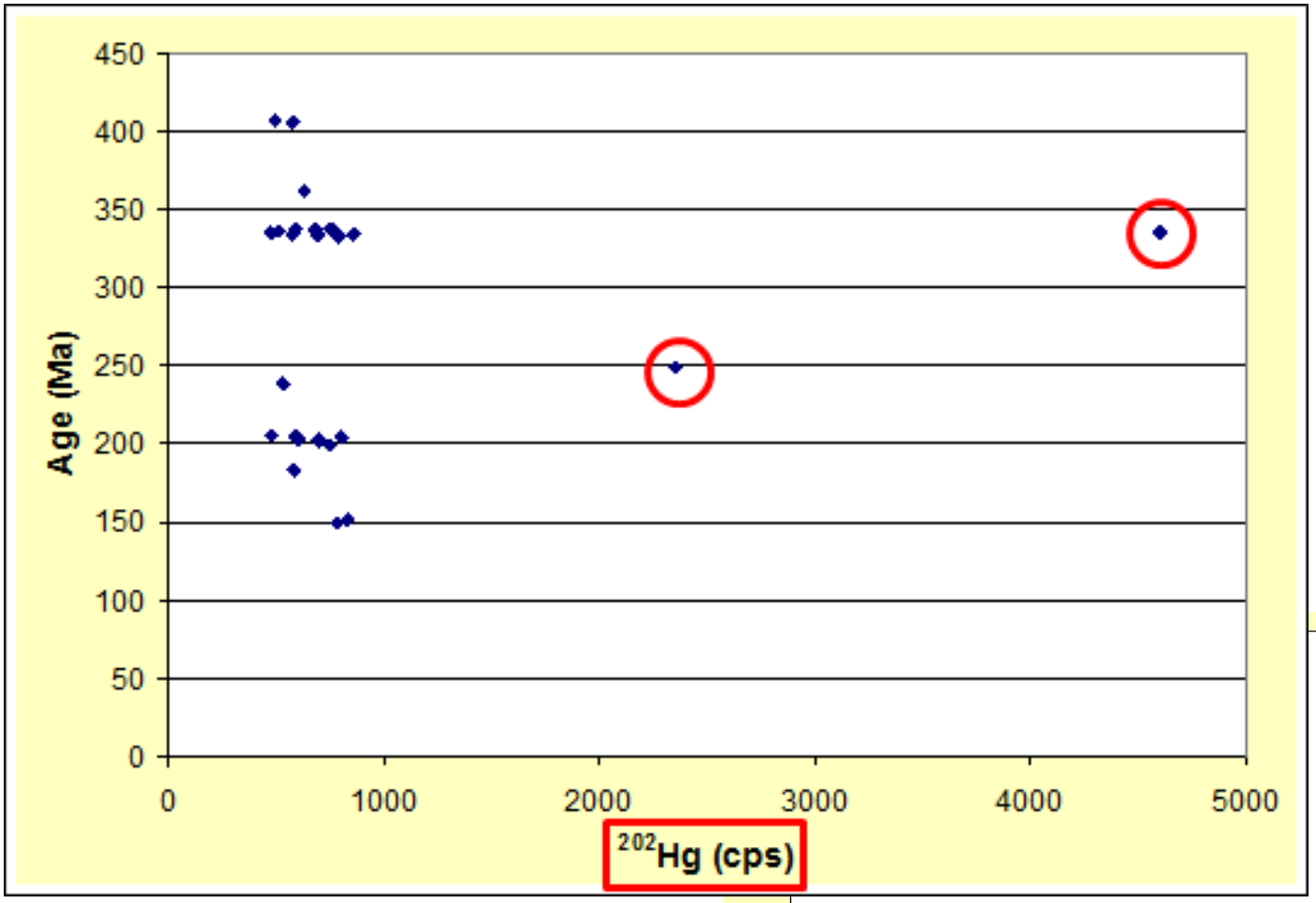
U/Th:
Petrogenesis?
Cogenetic?





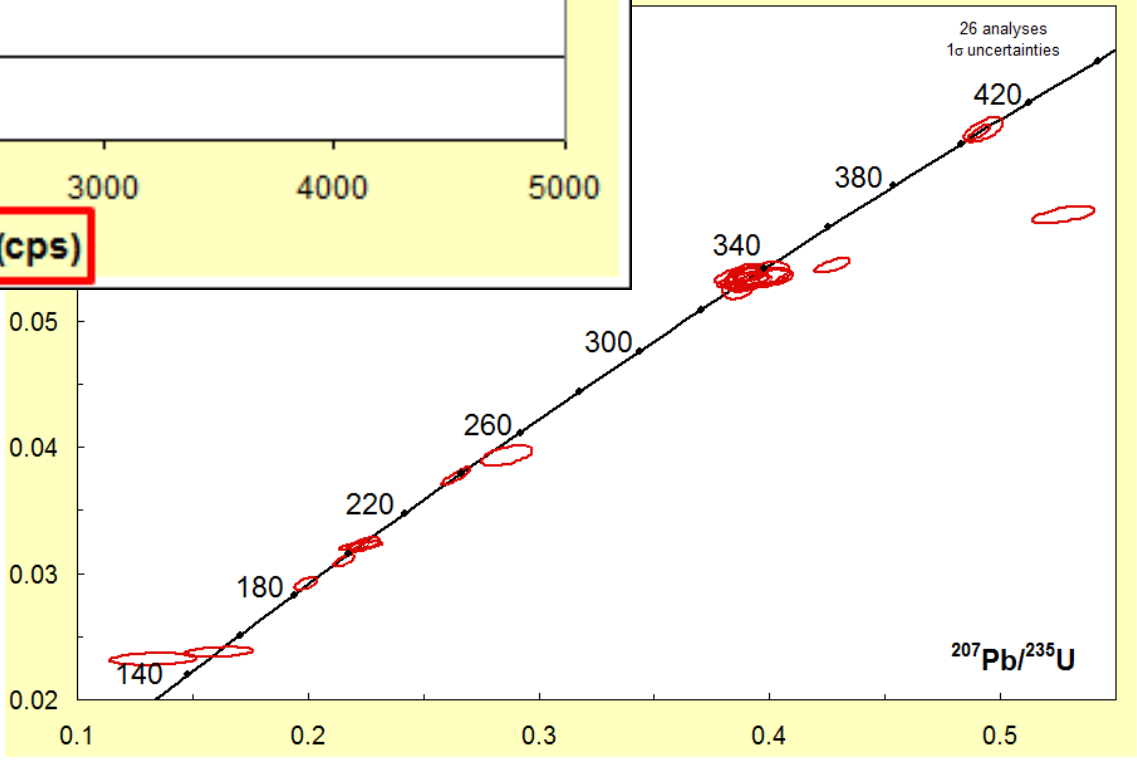
206/204:
Non-zircon?
Metamict?



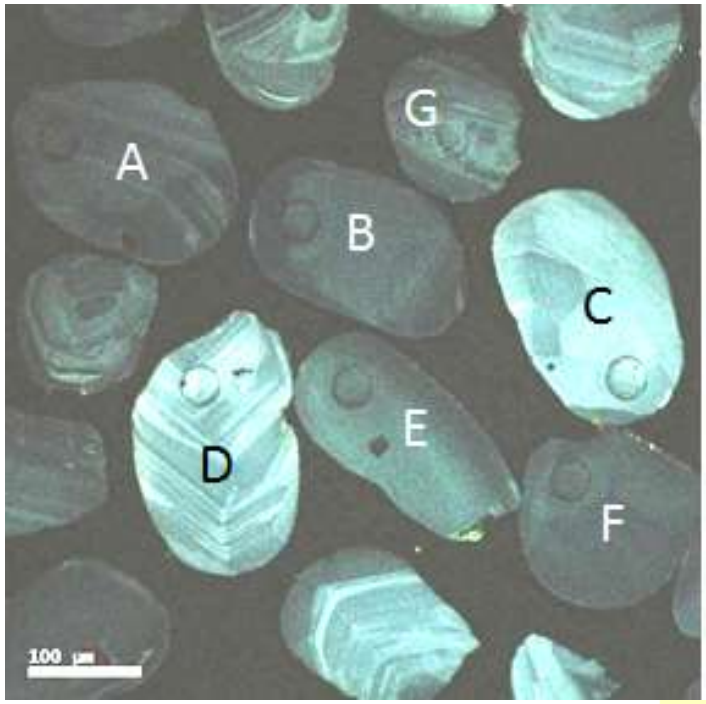


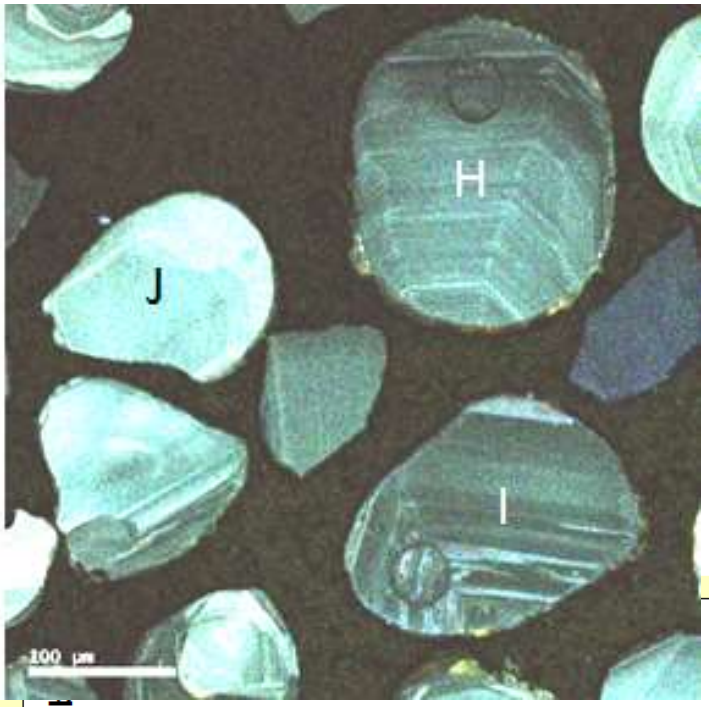
Hg abundance:

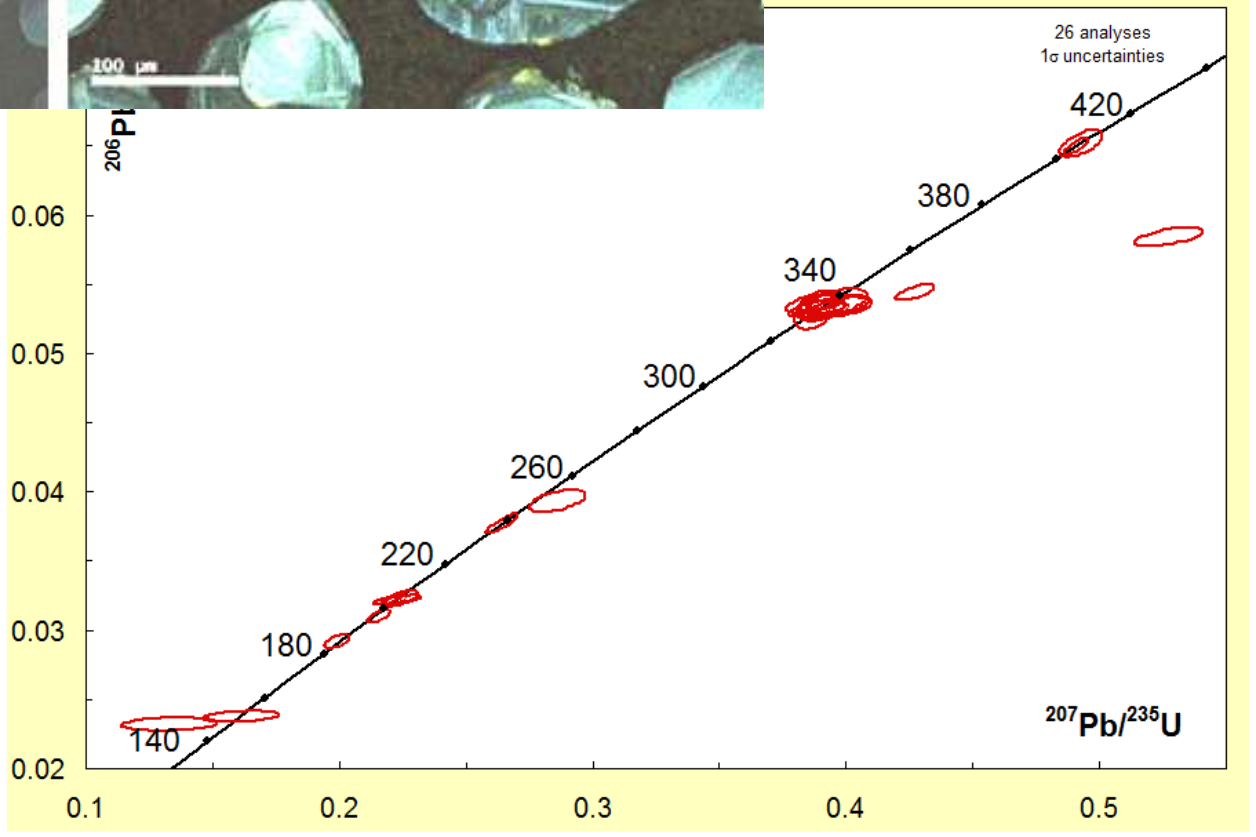
- Non-zircon?
- Analytical Issue?

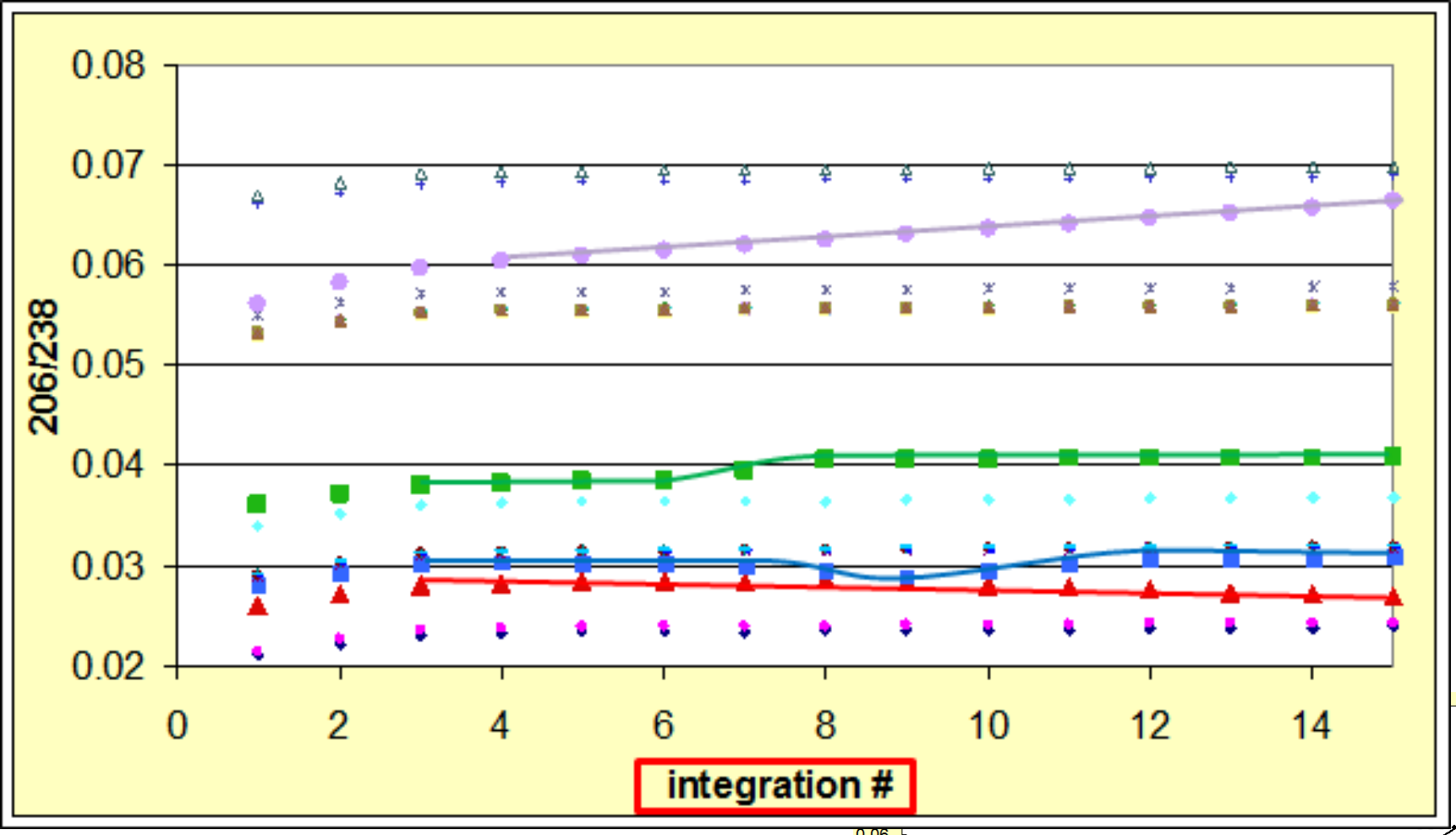


CL Images:
Zonation



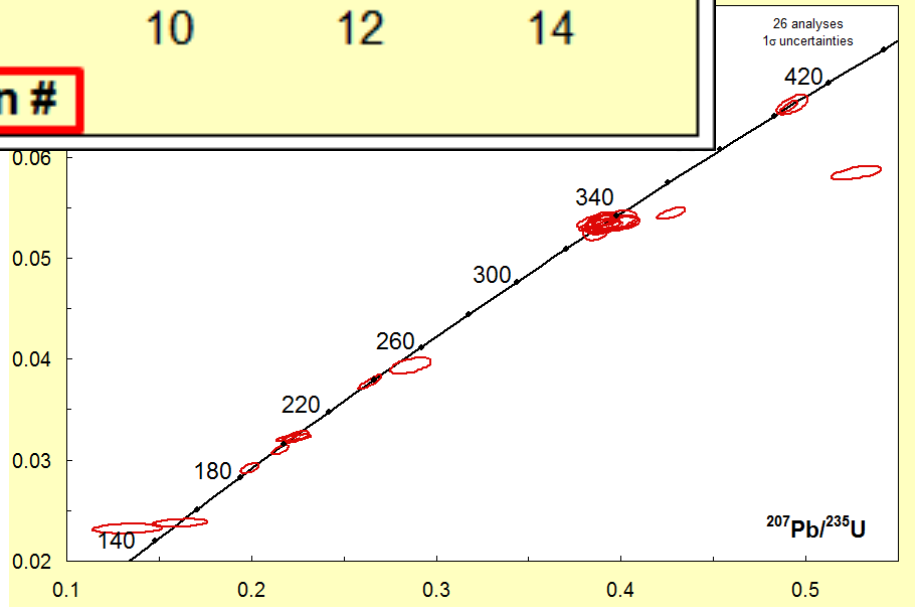


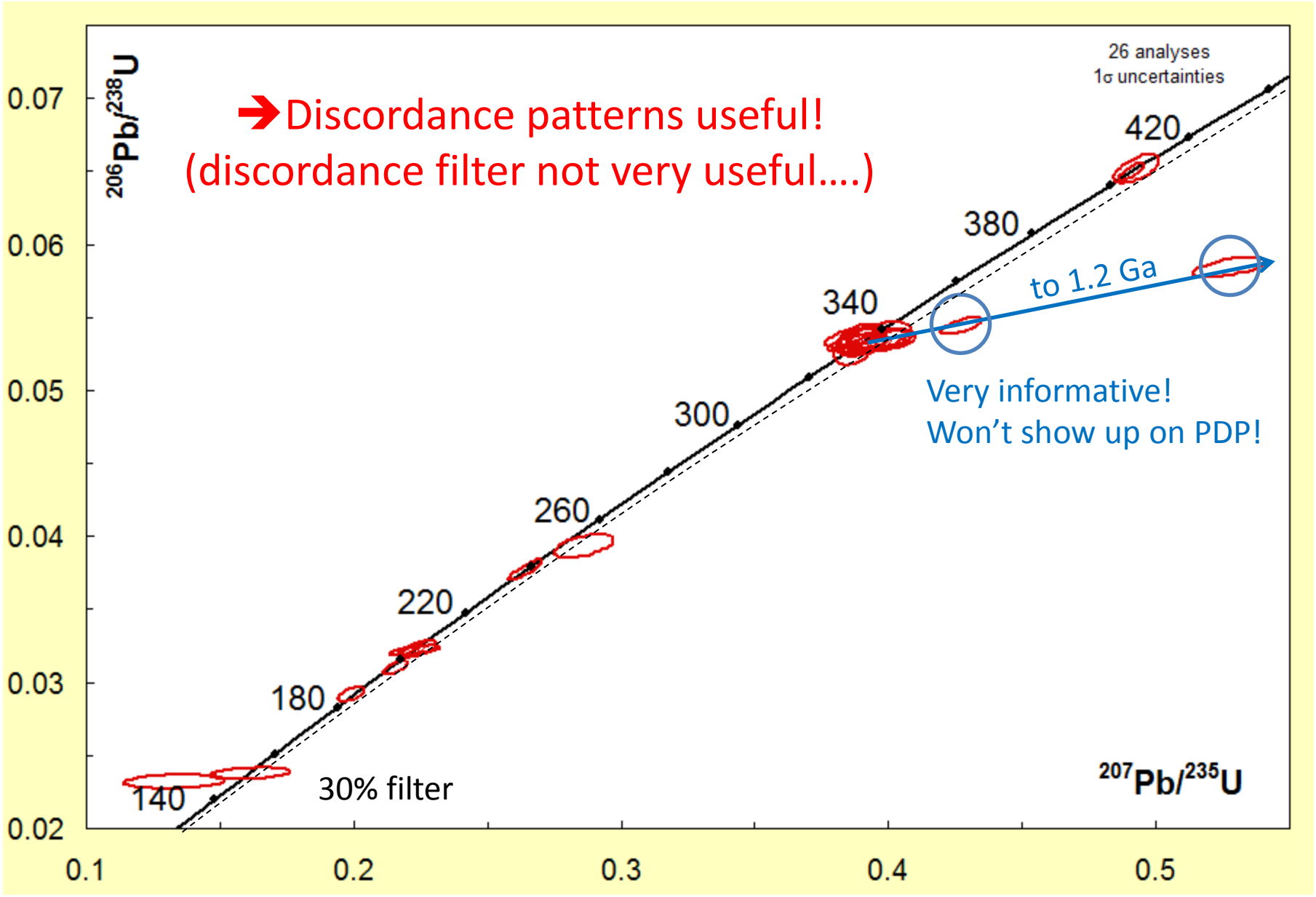




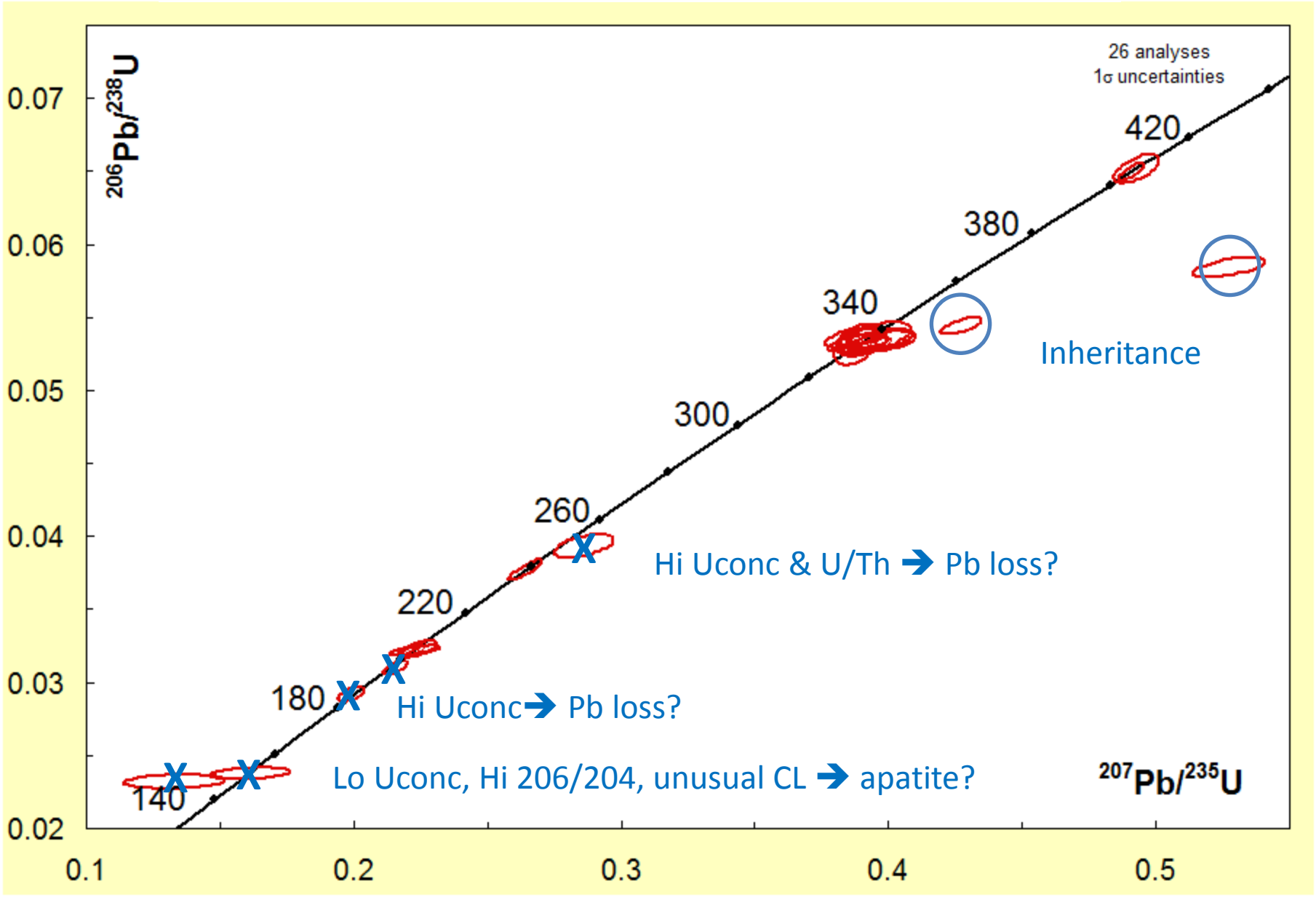
206/238 profile:

- Zonation?
- Fractures?
- Inclusions?




➔Discordance patterns useful!
(discordance filter not very useful….)
26 analyses
1σ uncertainties
$^{206}Pb/^{238}U$
$^{207}Pb/^{235}U$
0.07
0.06
0.05
0.04
0.03
0.02
0.1
0.2
0.3
0.4
0.5
140
180
220
260
300
340
380
420
30% filter
to 1.2 Ga
Very informative!
Won't show up on PDP!

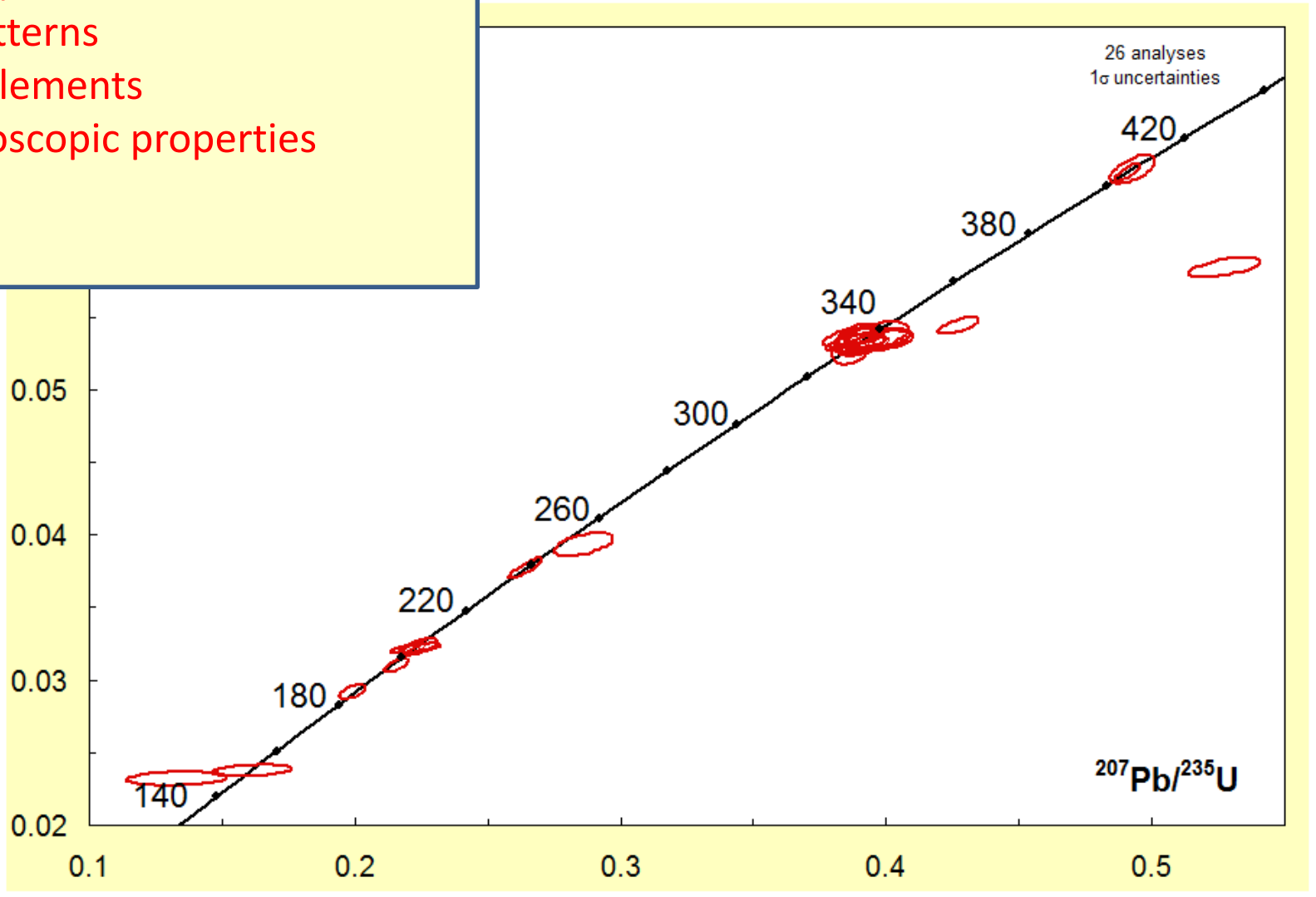
➔ Confident that remaining analyses are robust!



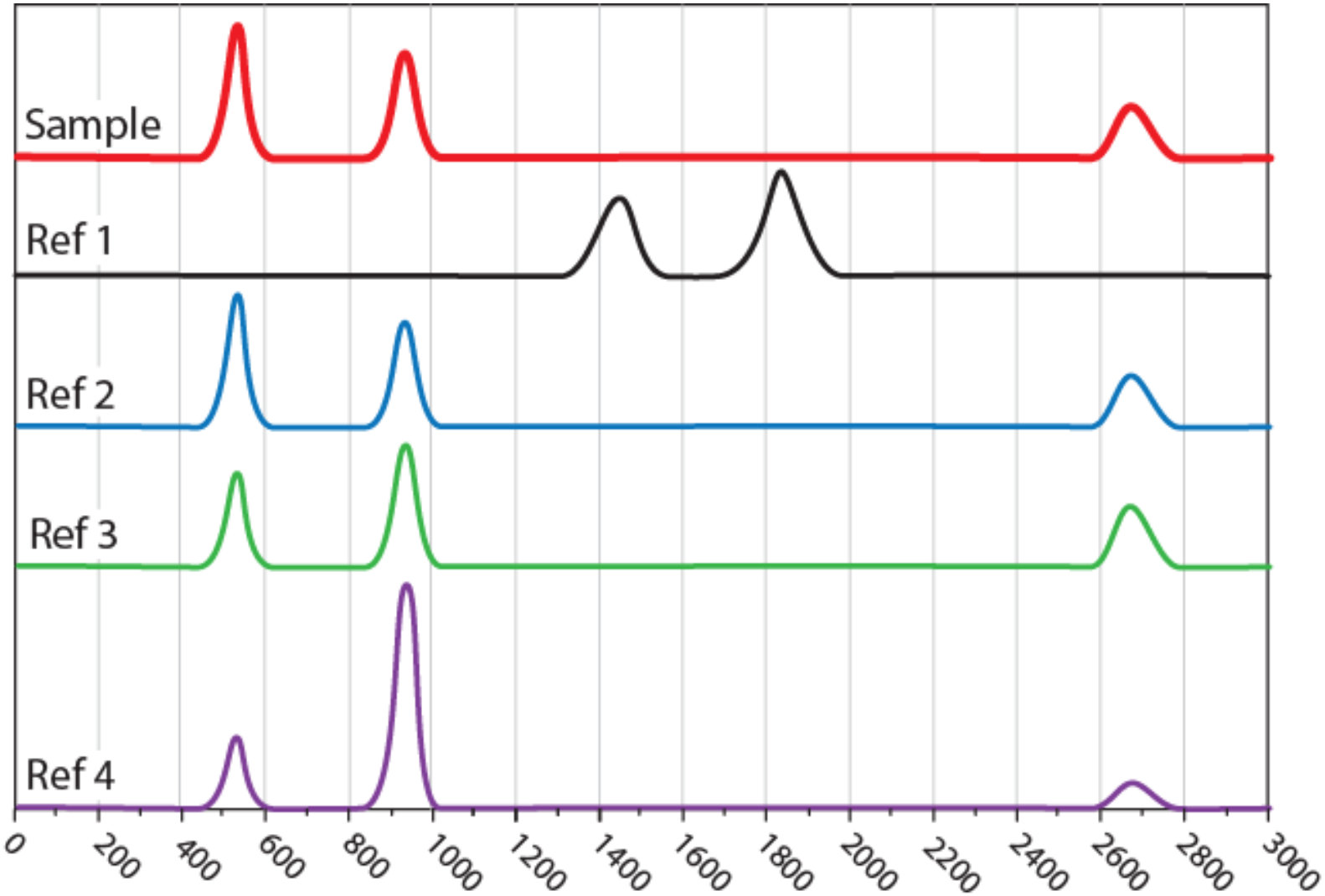
A multi-dimensional future:

- Multiple analyses on each grain
- Oxygen isotopes
- Hf isotopes
- Li isotopes
- REE patterns
- Trace elements
- Spectroscopic properties
- He age
- FT age

Need tools to access, view, & analyze information efficiently!



Number of analyses: presence-absence vs proportions



Presence/Absence ➔ not many analyses needed

Proportions ➔ lots of analyses needed!

Experiment with natural sample

American Journal of Science

DECEMBER 2008

SEDIMENT DELIVERY TO THE CORDILLERAN FORELAND BASIN: INSIGHTS FROM U-Pb AGES OF DETRITAL ZIRCONS IN UPPER JURASSIC AND CRETACEOUS STRATA OF THE COLORADO PLATEAU

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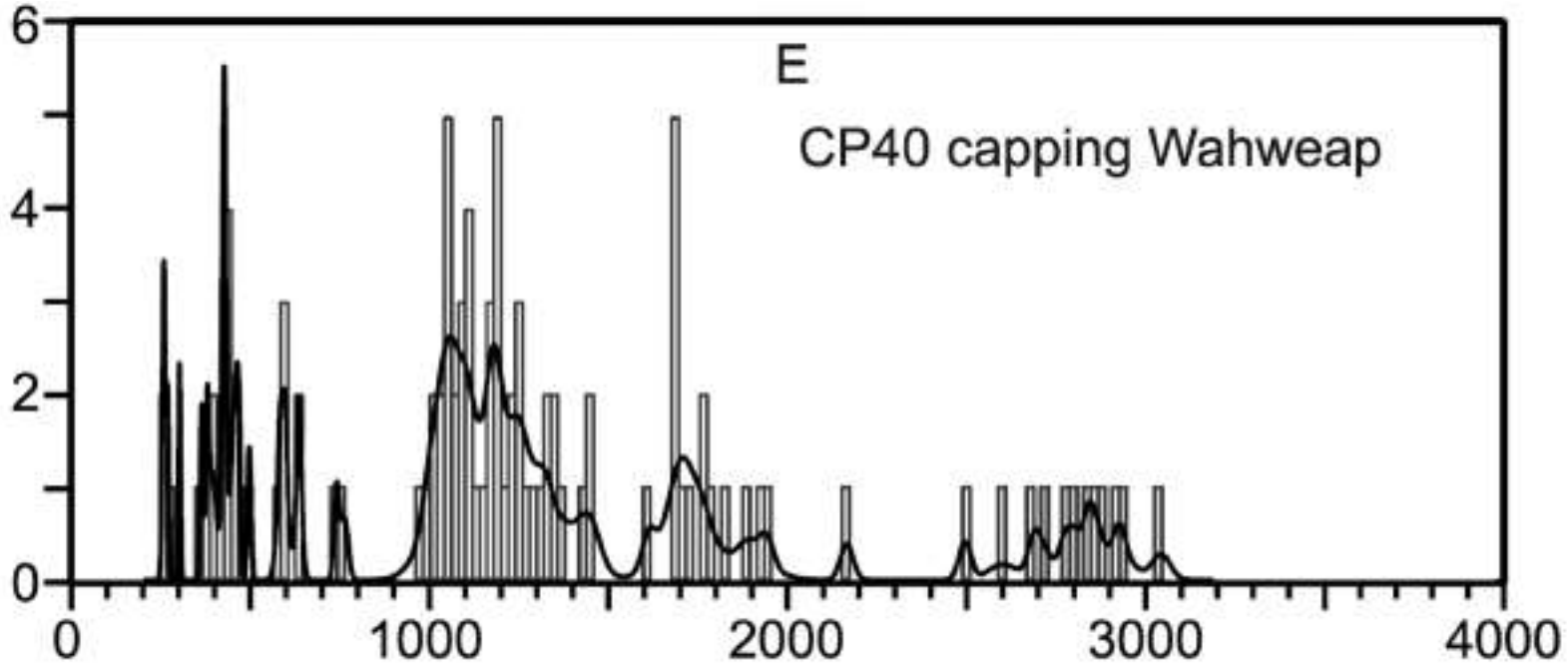
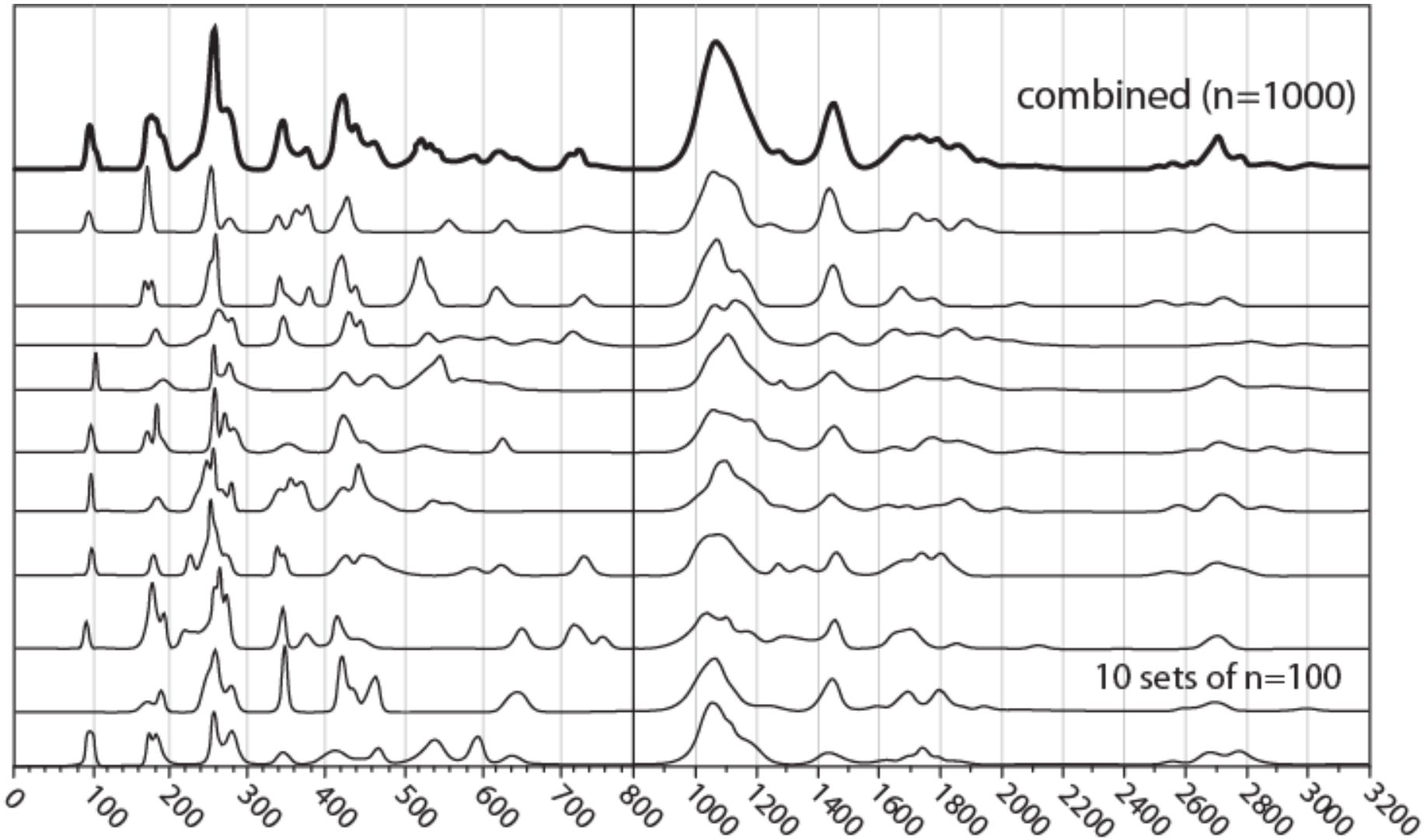
Department of Geosciences, University of Arizona, Tucson, Arizona 85721 U.S.A.; wrdickin@dakotacom.net

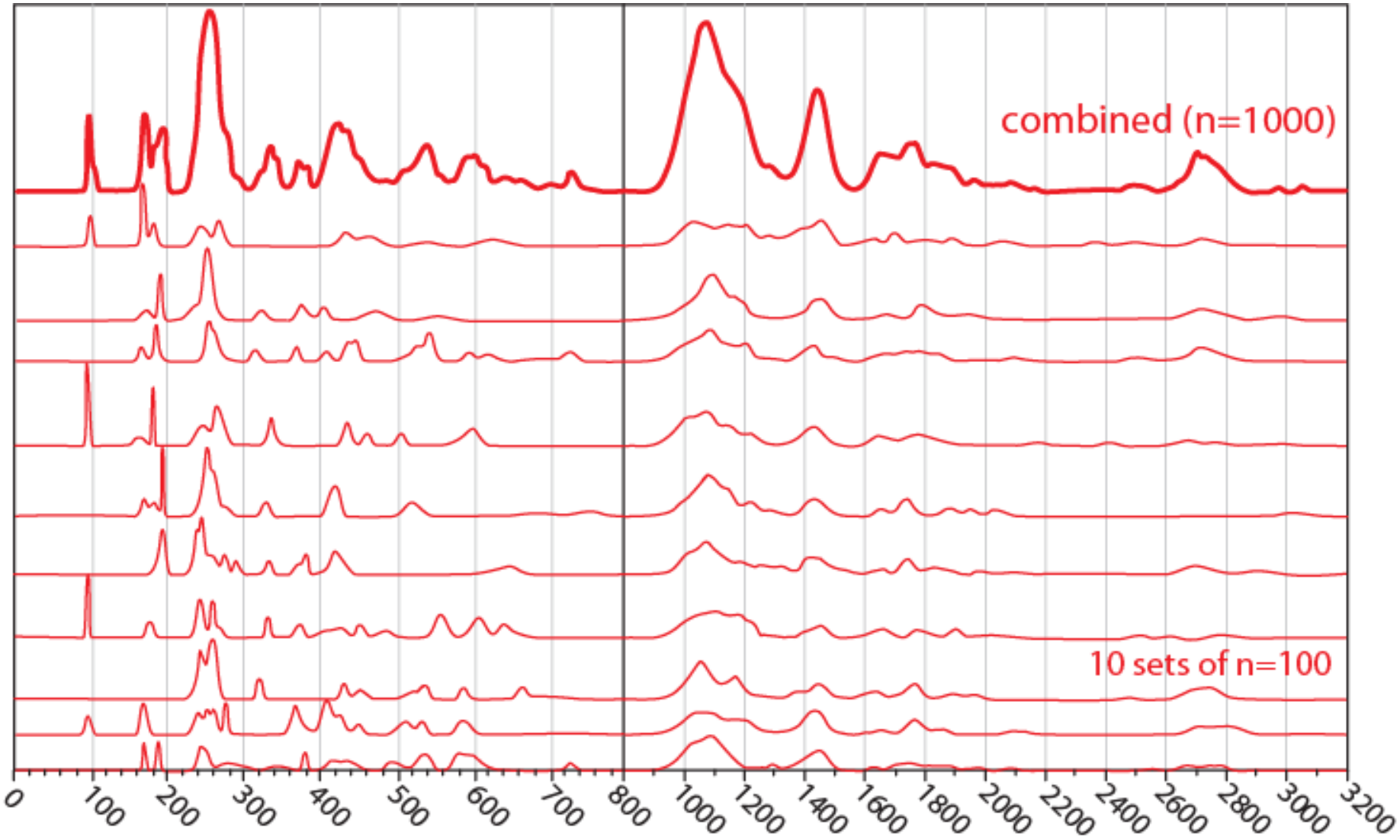


10 sets of n=100 analyses (first set, random selection)

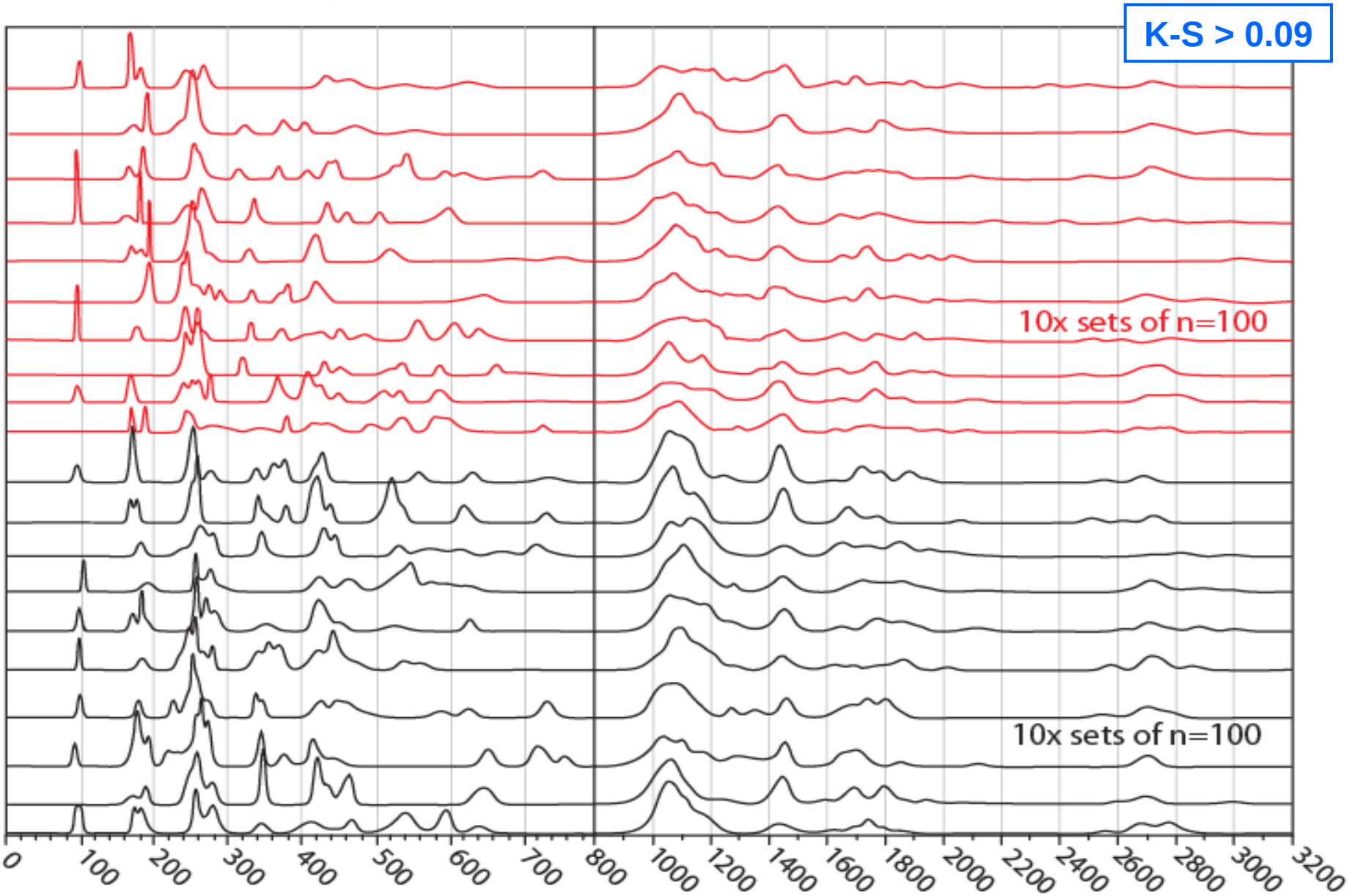


5 sec backgrounds, 4 sec peaks, 10 sec purge (semi-automated)

10 sets of n=100 analyses (second set)

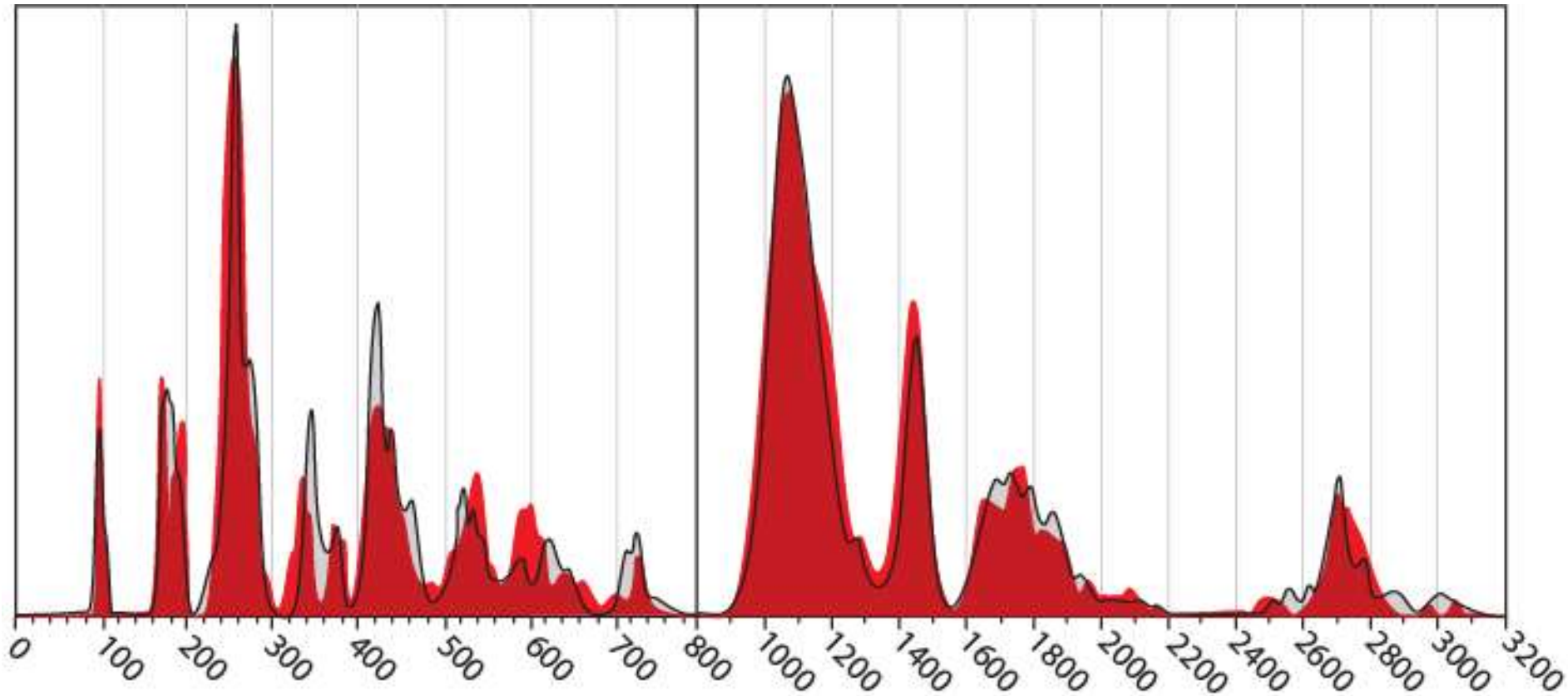


➔ n=100 not great for presence/absence or proportions



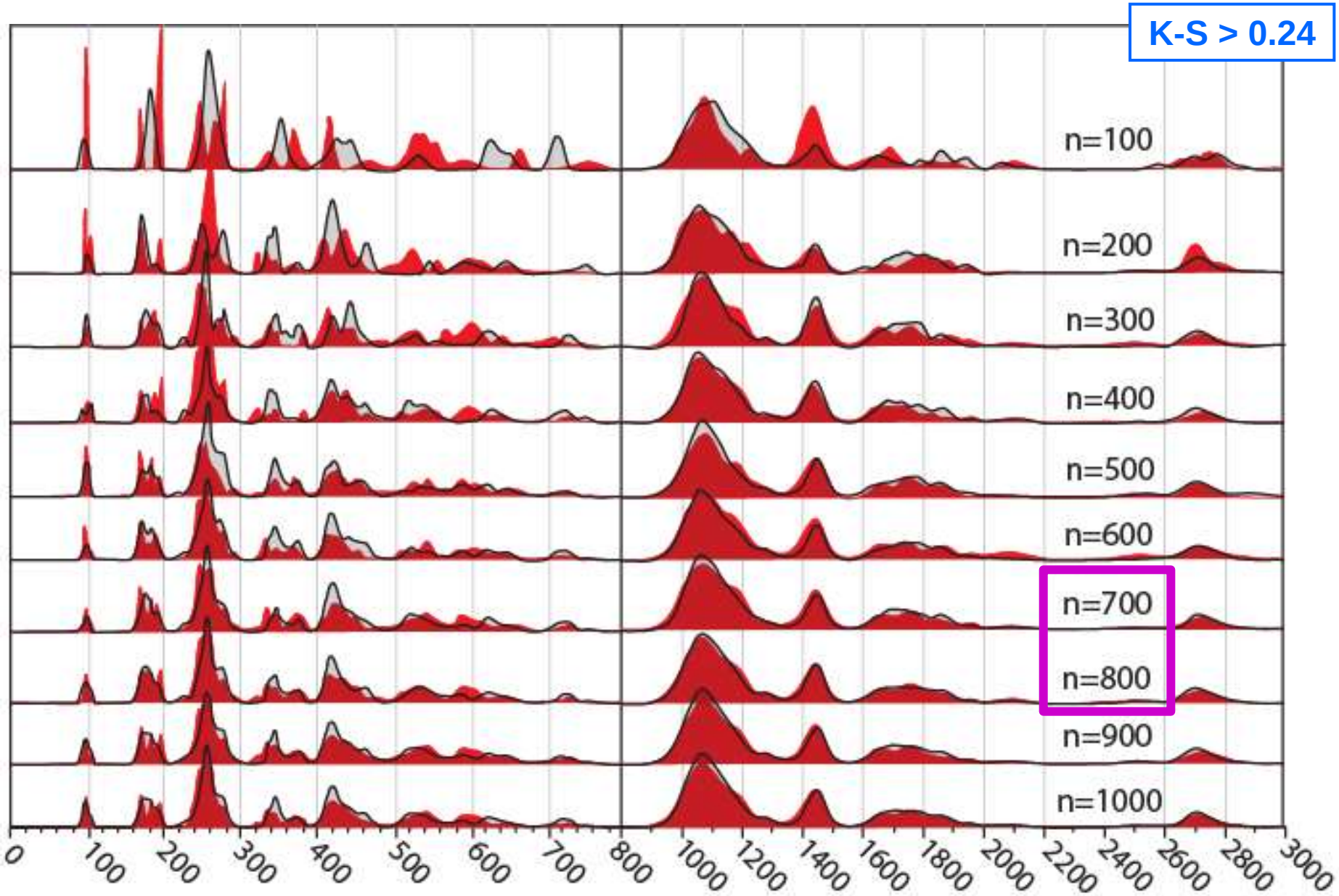
➔ n=1000 much more robust

K-S = 0.65

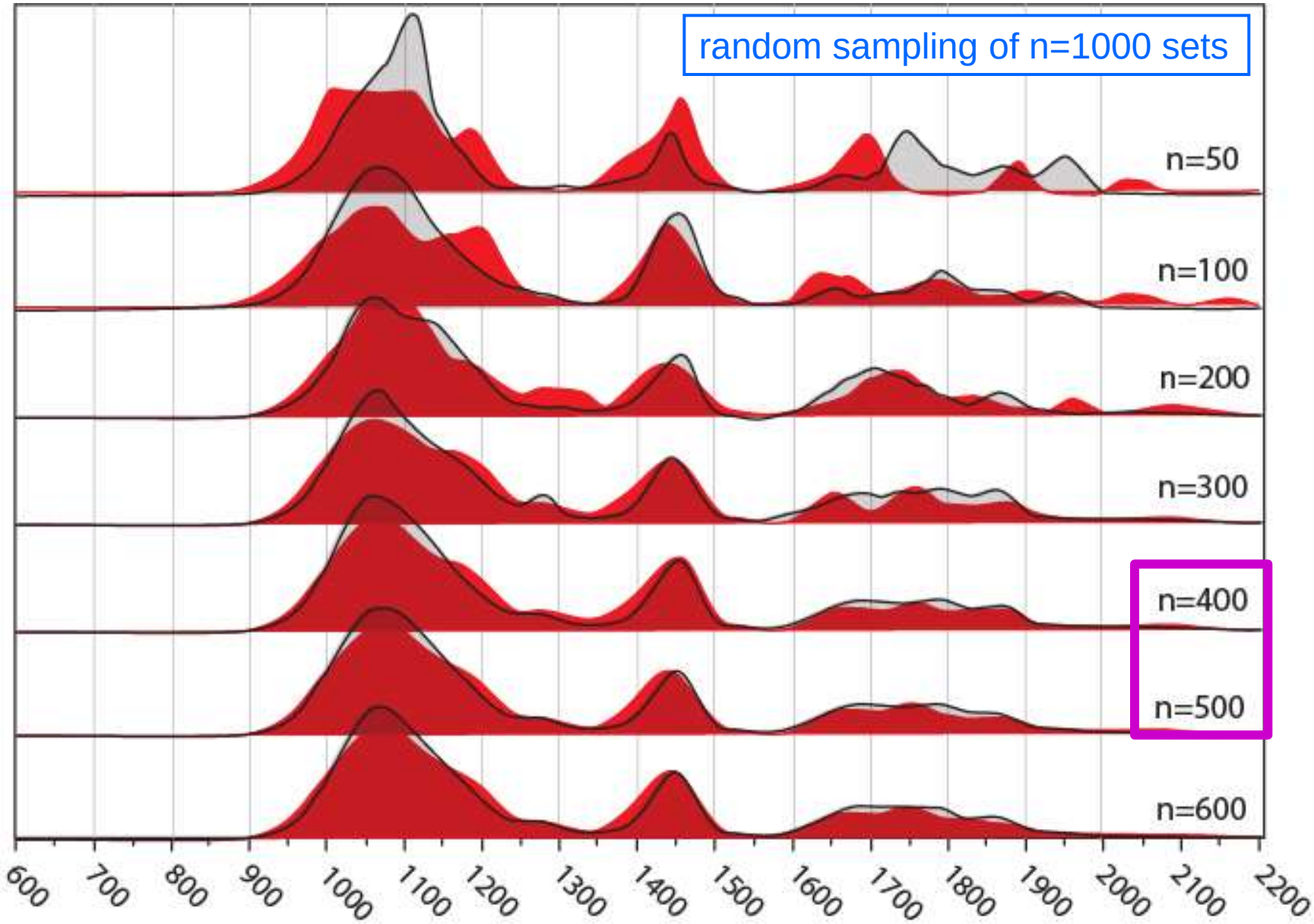


set #1 of n=1000 set #2 of n=1000

How many analyses needed for ~9 age groups?

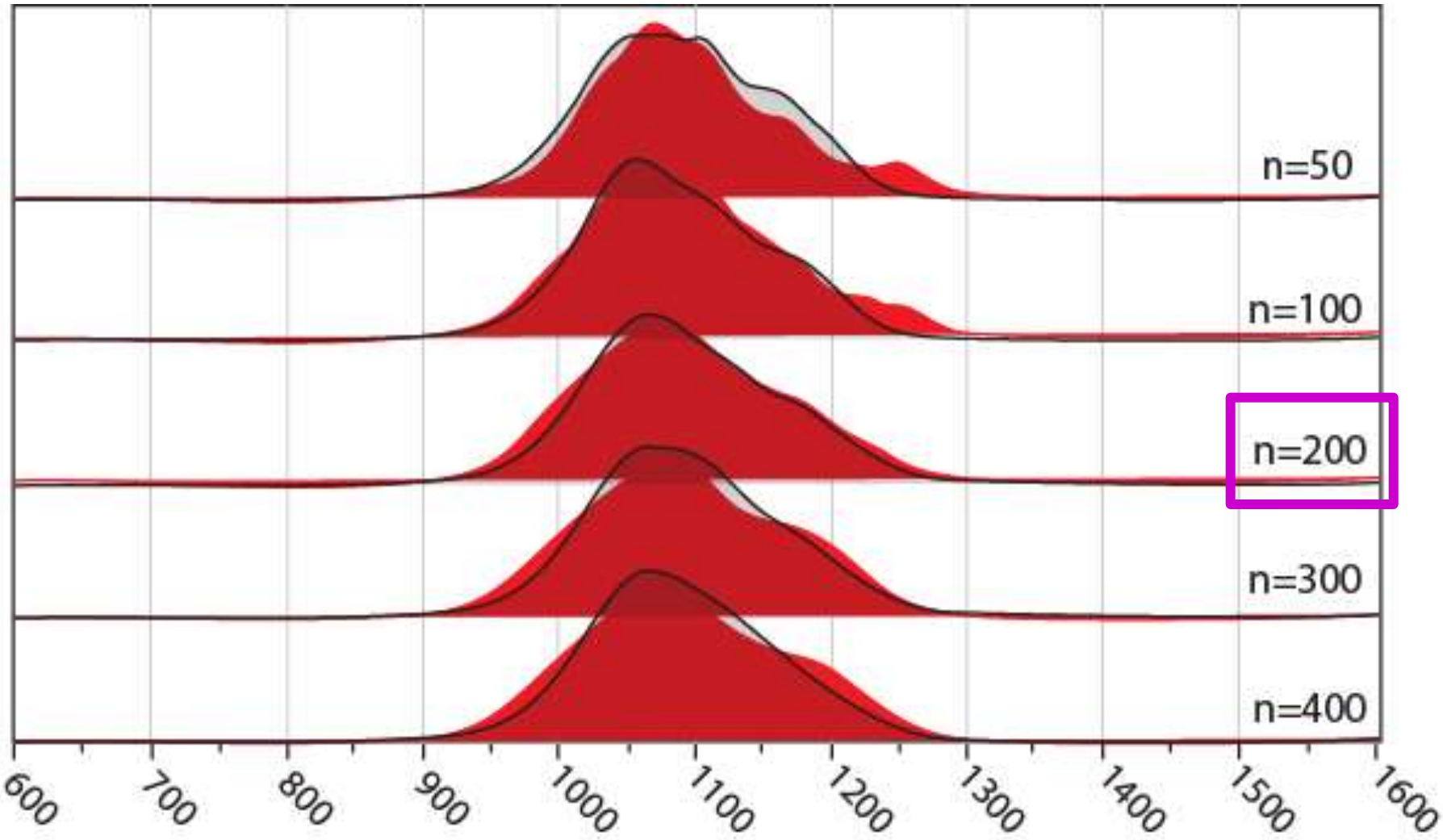


How many analyses needed for ~3 age groups?



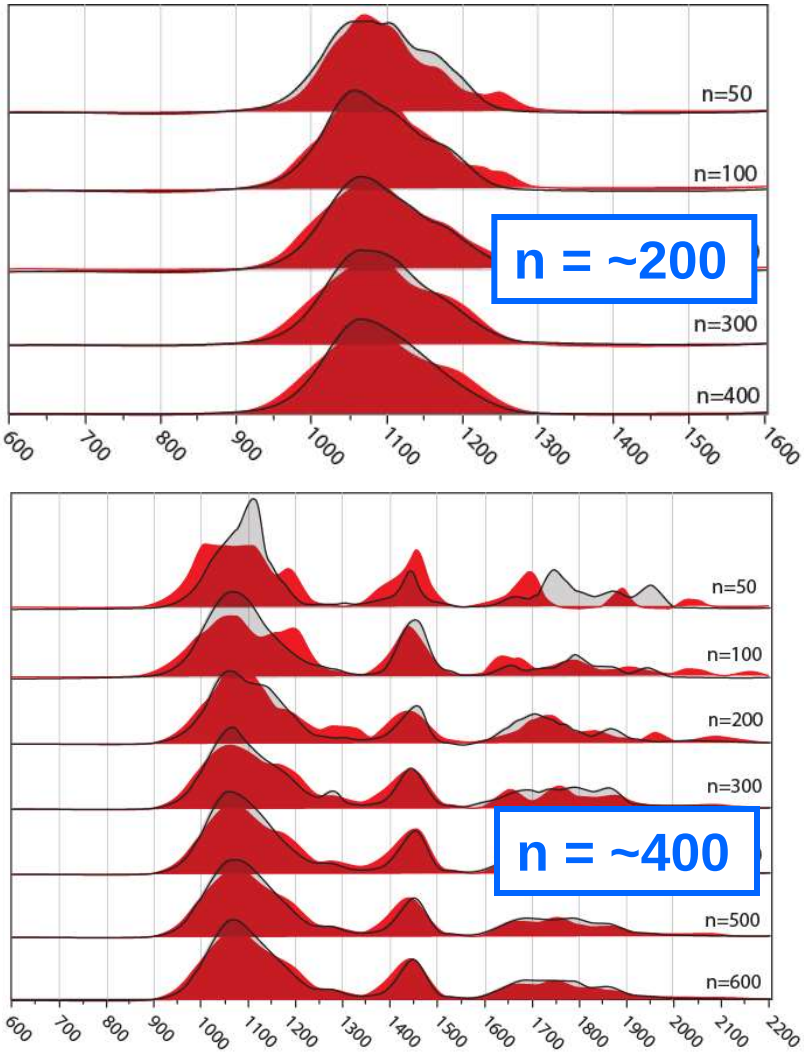
How many analyses needed for 1 age group?

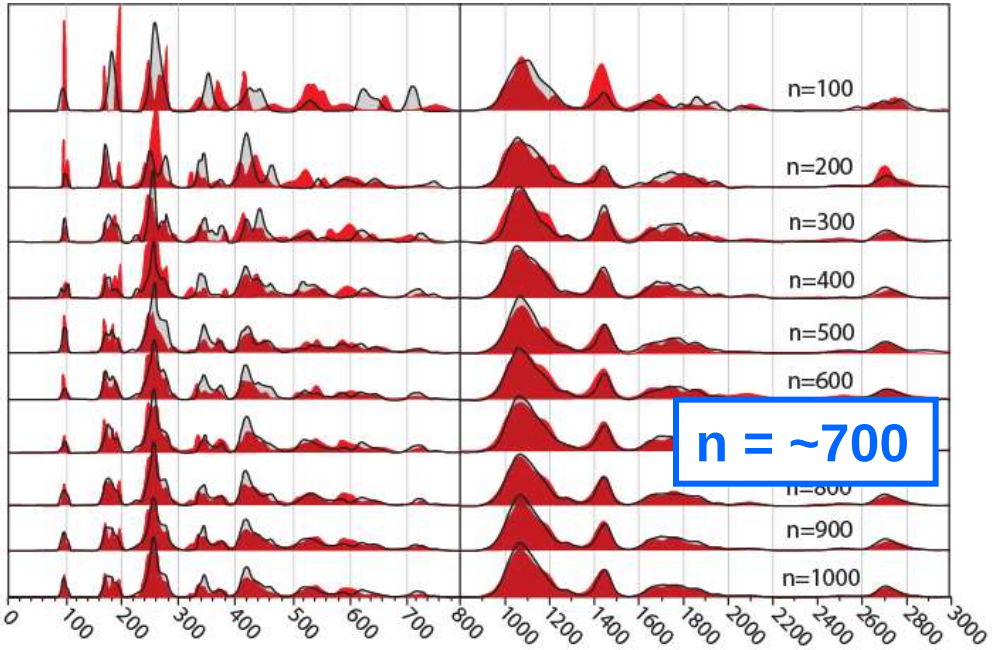
random sampling of n=1000 sets



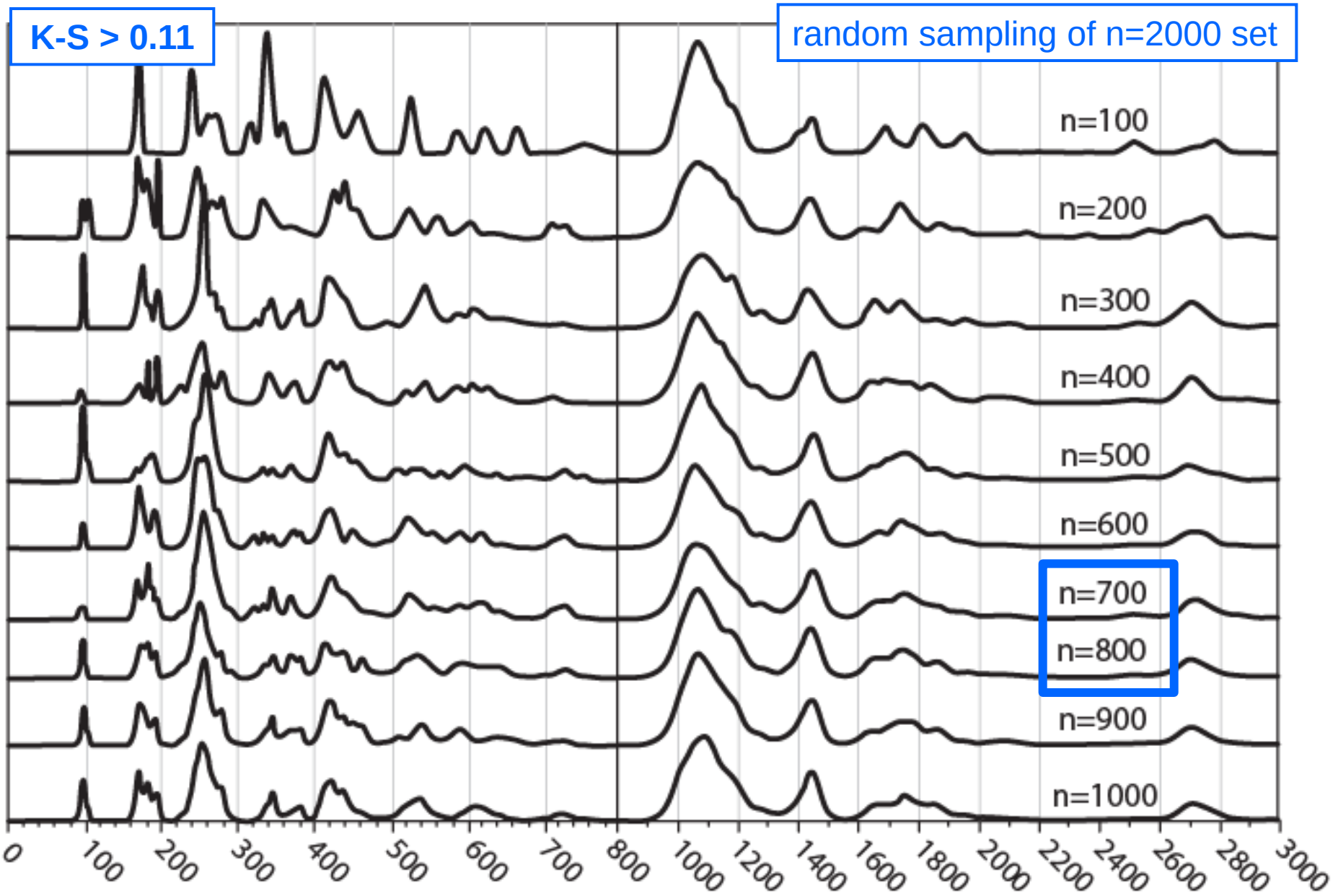
How many needed?

➔ depends on number of age groups!



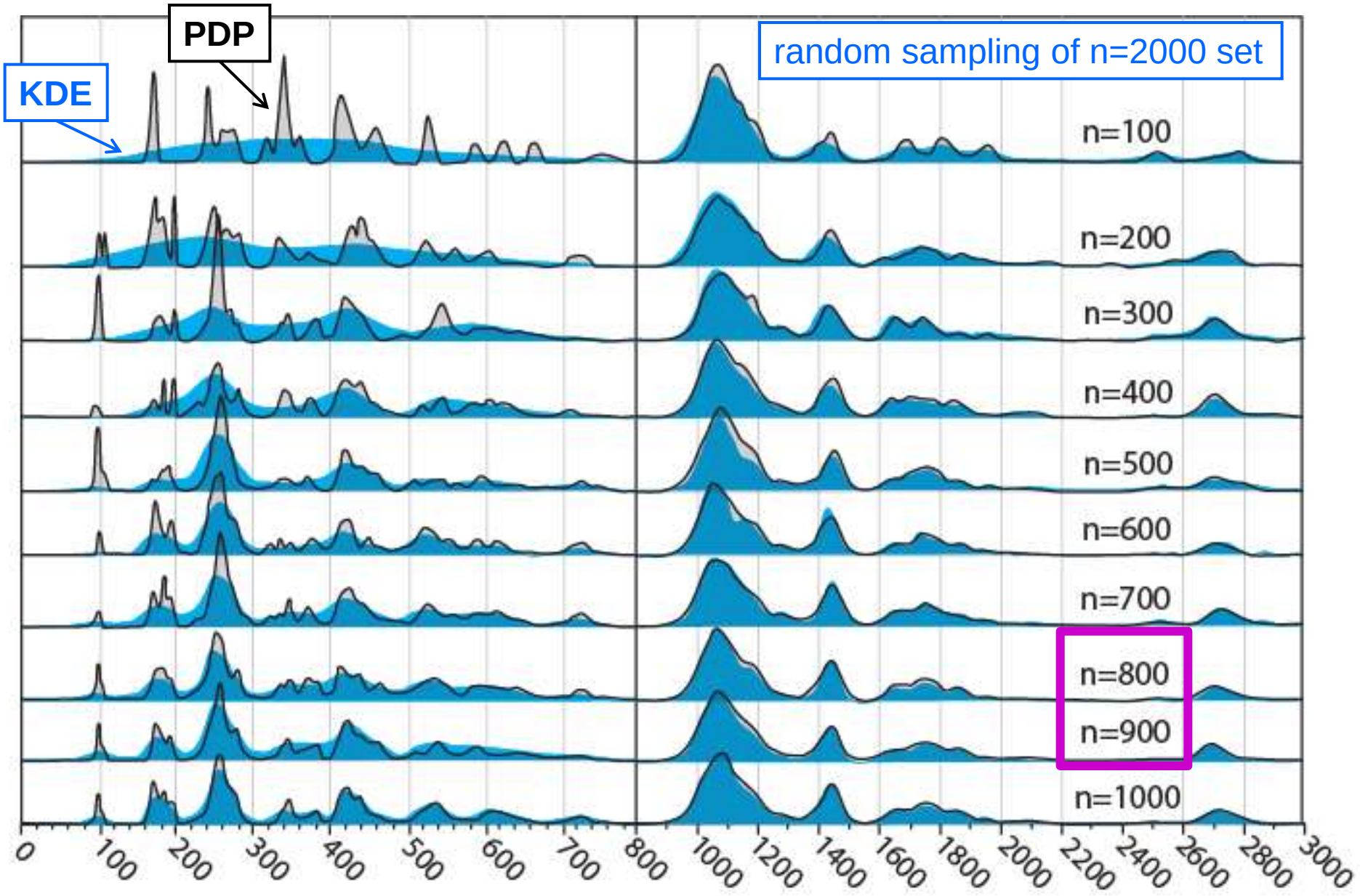


Strategy: Acquire data until PDP doesn't change…

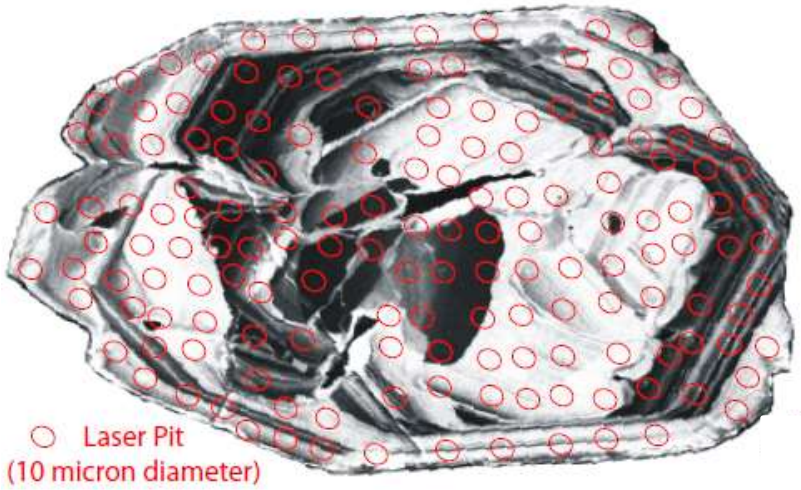


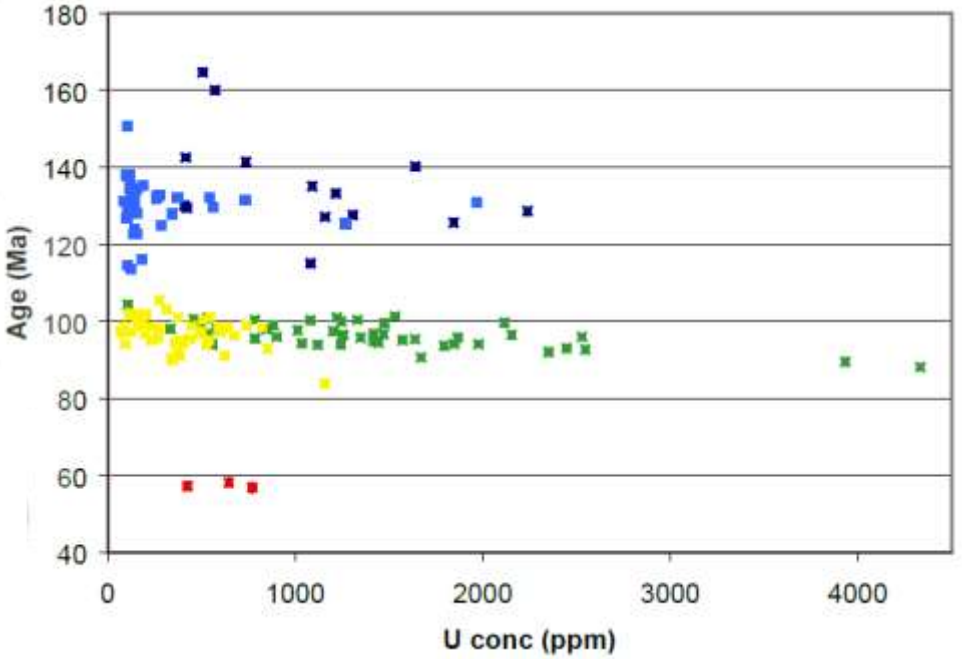
Strategy: Acquire data until PDP matches KDE?

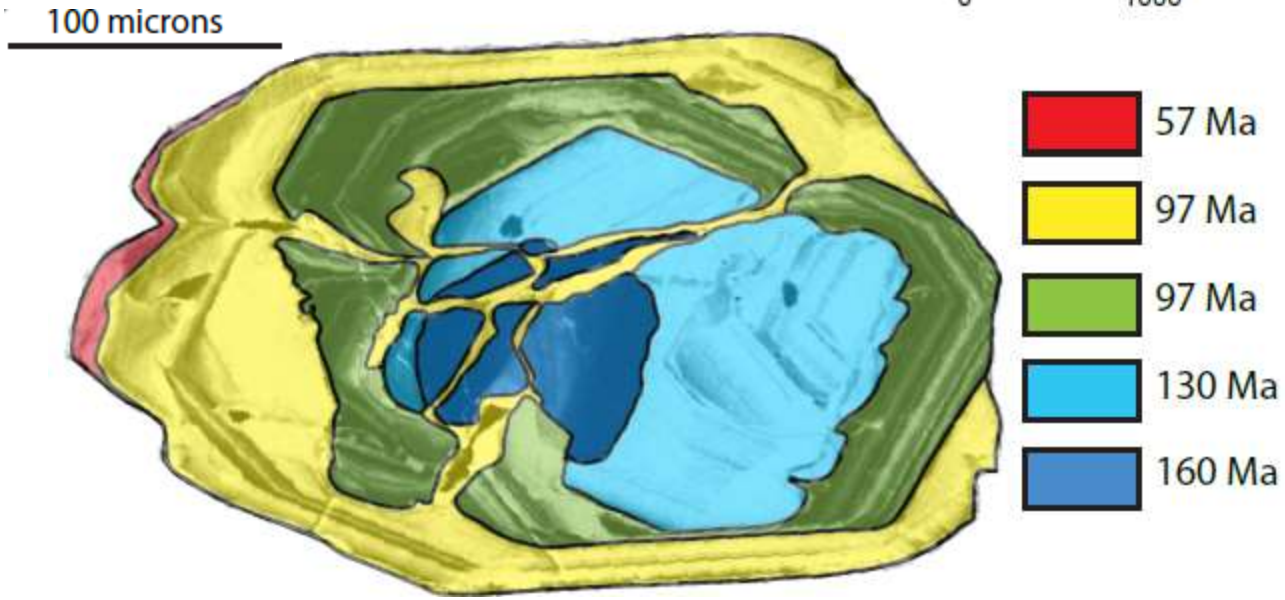
(KDE calculation fom Vermeesch, 2012)



Can also apply methodology to complex grains







Large-n geochronology

Essential for more robust & quantitative provenance analysis
➔ proportions in addition to presence/absence

Current normal acquisition: 2 hours for 100 analyses

Semi-automated acquisition: 6 hours for 1000 analyses

Pretty clunky:

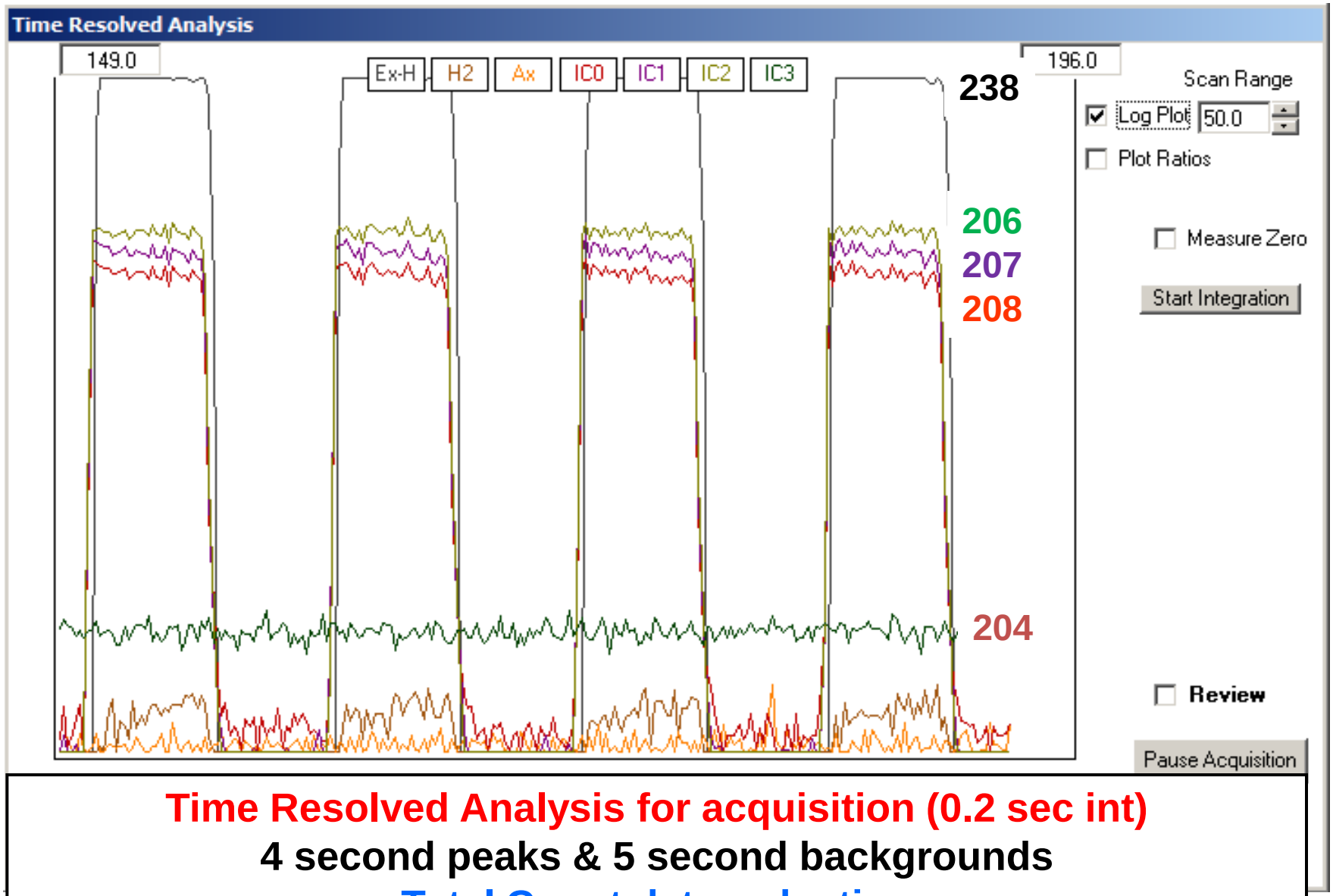
➔ Efficient acquisition/use of BSE/CL images *(working with Gatan)*
➔ Off-line targeting *(working with Photon Machines)*
➔ Laser auto-focus *(working with Photon Machines)*
➔ Robust protection on mass spec *(working with Nu Instruments)*

Need software that calculates ages, conc plots, PDP, & KDE real-time

Need to develop better tools for comparison of data sets

**Note previous/ongoing efforts by Frei & Gerdes (2009), Cottle et al. (2009, 2012), Johnston et al. (2009)*

Acquisition of n>100 analyses: mass spec

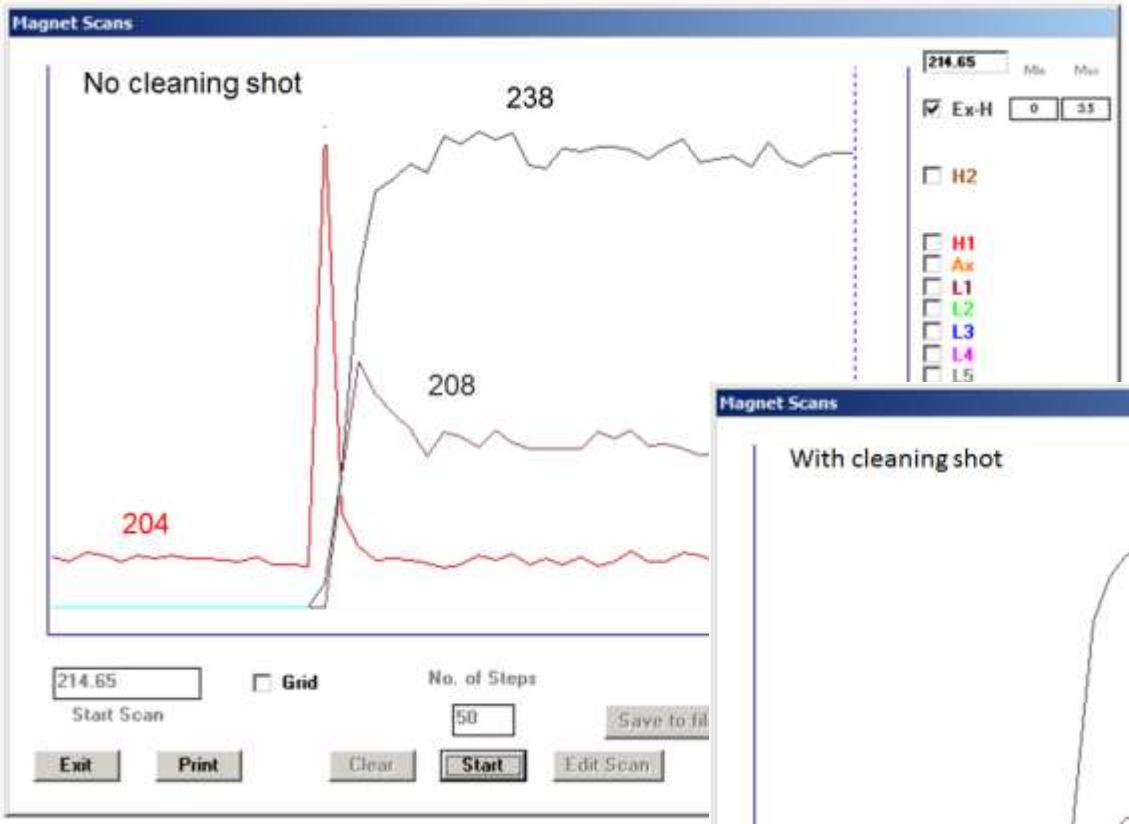


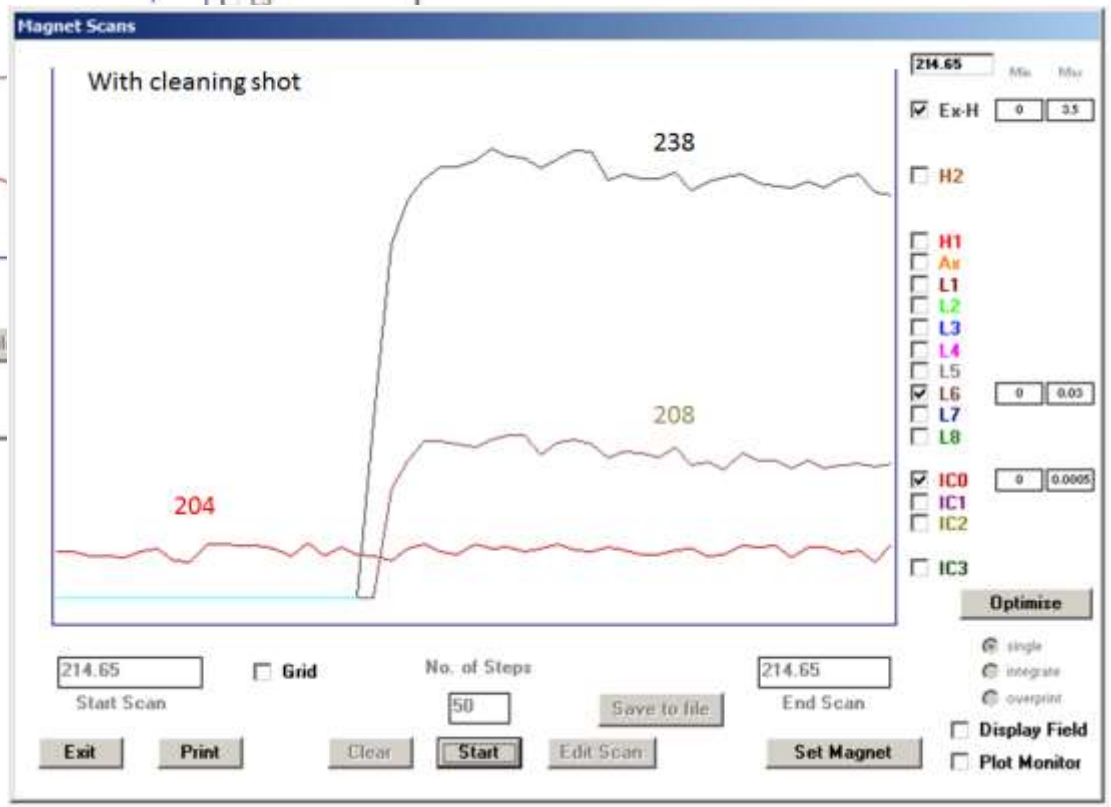
Time Resolved Analysis for acquisition (0.2 sec int)

4 second peaks & 5 second backgrounds

Total Count data reduction

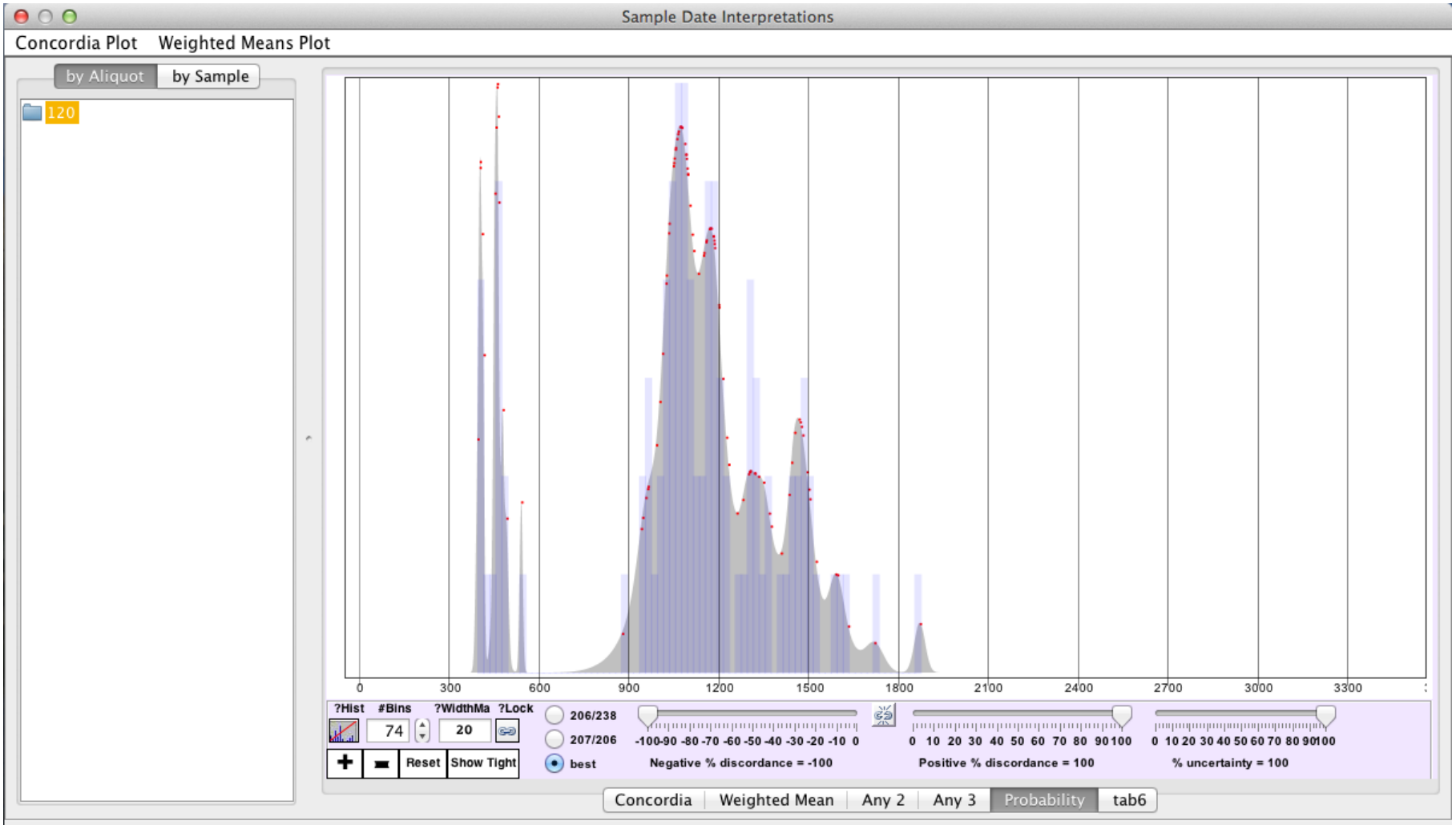
Acquisition of n>100 analyses: cleaning shots





Cleaning Shots required!

Acquisition of n>100 analyses: real-time PDP



design software that generates PDP real-time during acquisition
(Jim Bowring, Doug Walker, Noah McLean of EarthChem, EARTHTIME, Cirdles)