The Thermochronologist's Progress

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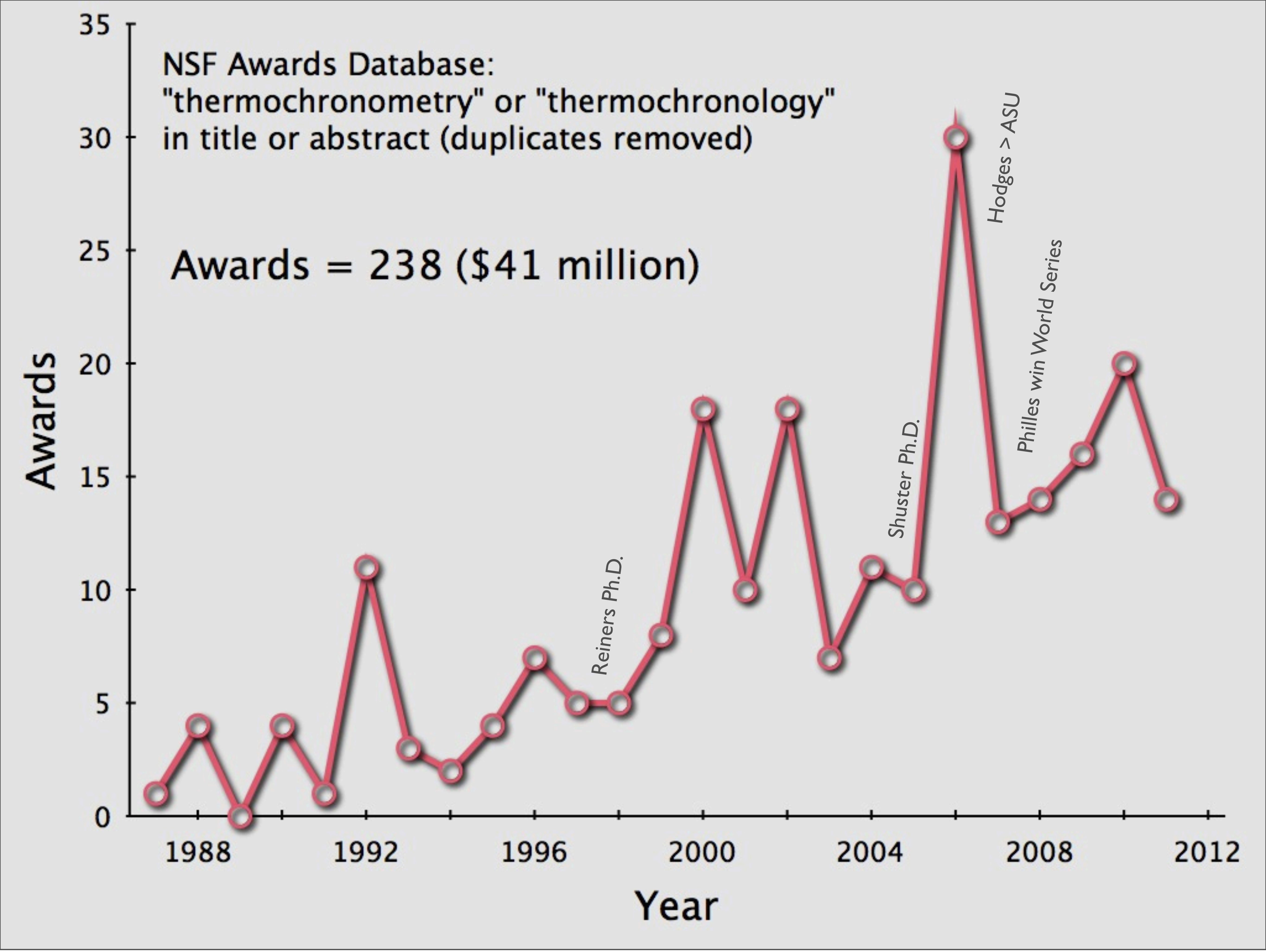
The Thermochronologist's Progress

- Context and complexion of our discipline
- Accomplishments and progress
- Key issues and future directions

25 Years of Thermochronology?

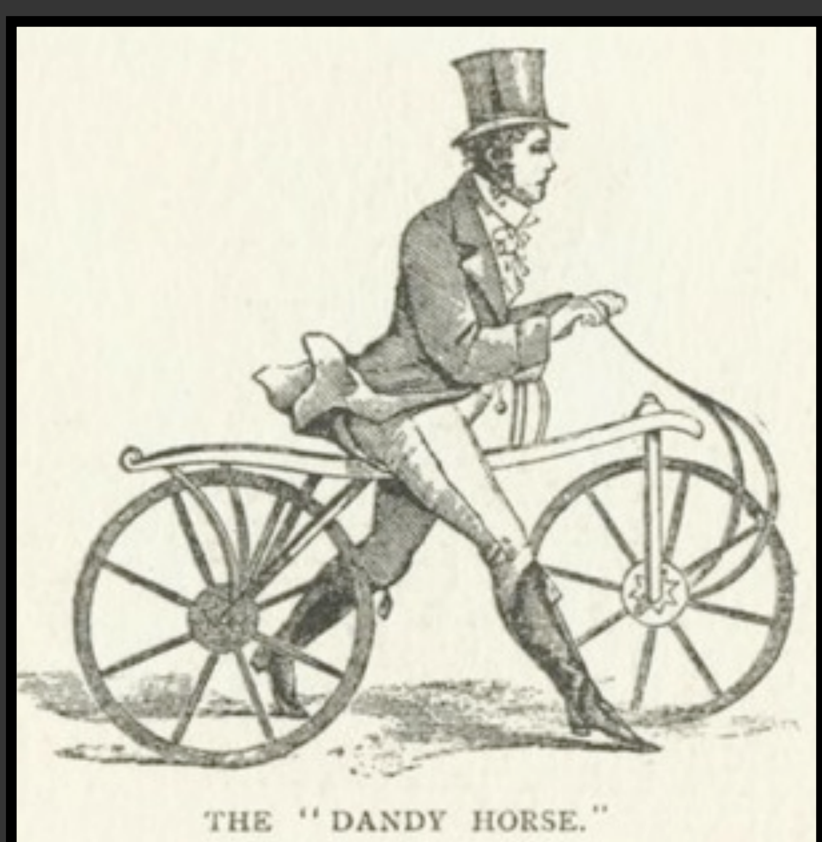
the dachshund of time (via BSNYC)


NSF Awards Database:
"thermochronometry" or "thermochronology"
in title or abstract (duplicates removed)
Awards = 238 ($41 million)
Reiners Ph.D.
Shuster Ph.D.
Hodges > ASU
Philles win World Series
Awards
Year
0
5
10
15
20
25
30
35
1988
1992
1996
2000
2004
2008
2012

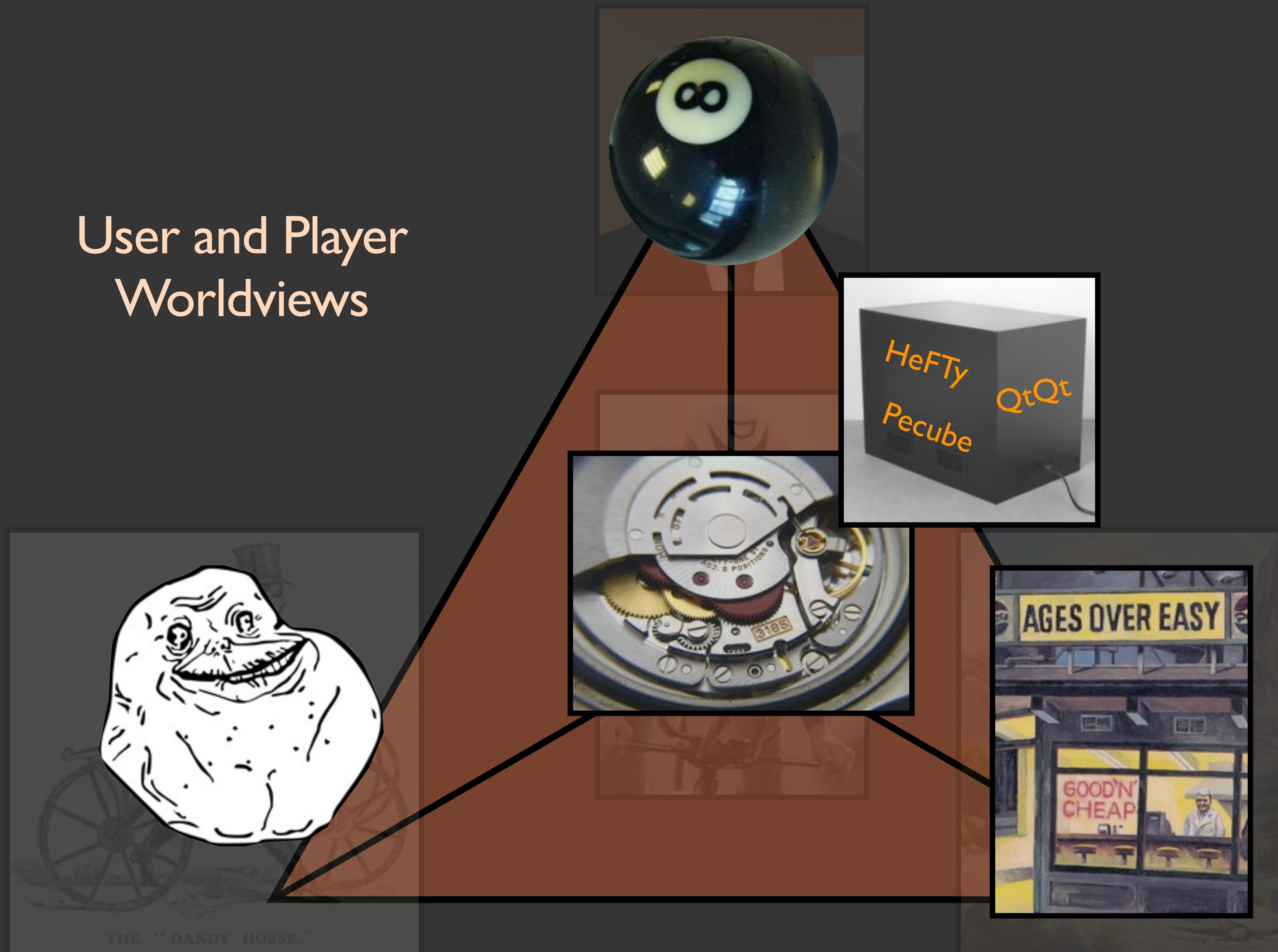
Users and Players

The quaternary system modelers – thermochronologists – mineralogists – geologists

- Complete solid solution
- More components possible



User and Player Worldviews



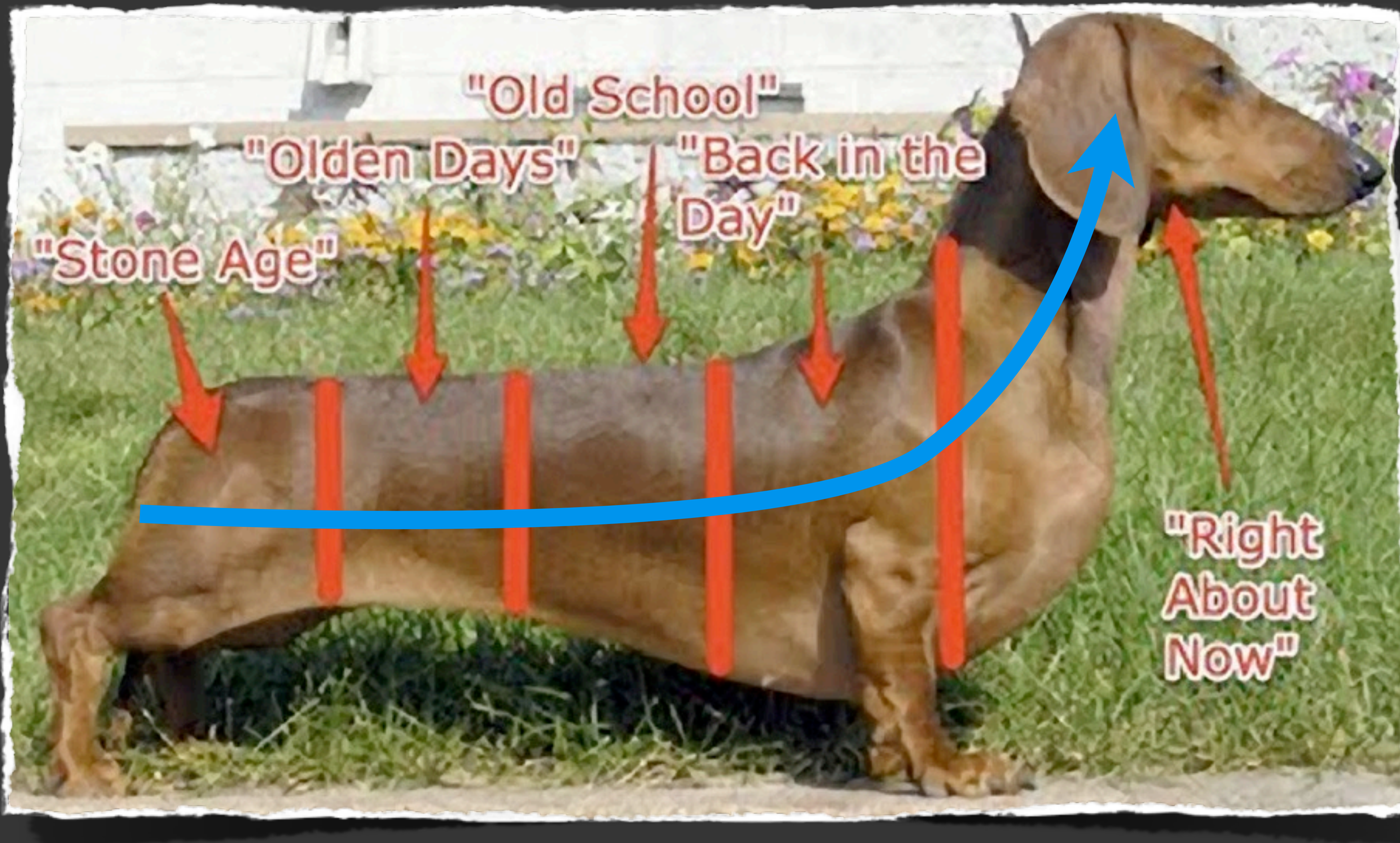
Quiz: Thermochronology's Achievements

List thermochrononology's game-changing outcomes. What fundamental measurements or ideas are in textbooks or known by the educated public?

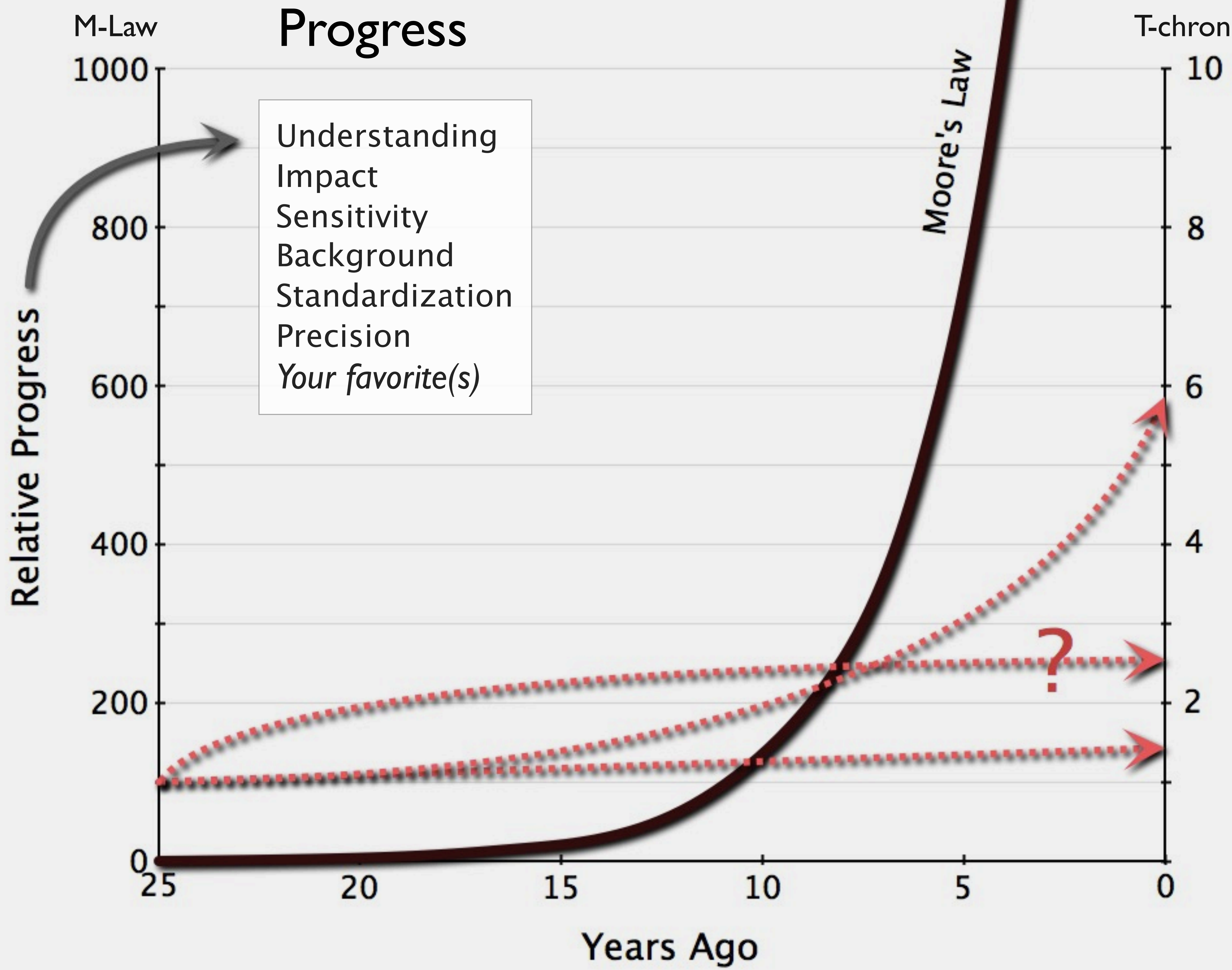
You have 23 seconds.

1. rates?	6.
2. dates?	7.
3.	8.
4.	9.
5.	10.

~~25~~ 50 Years of Progress?

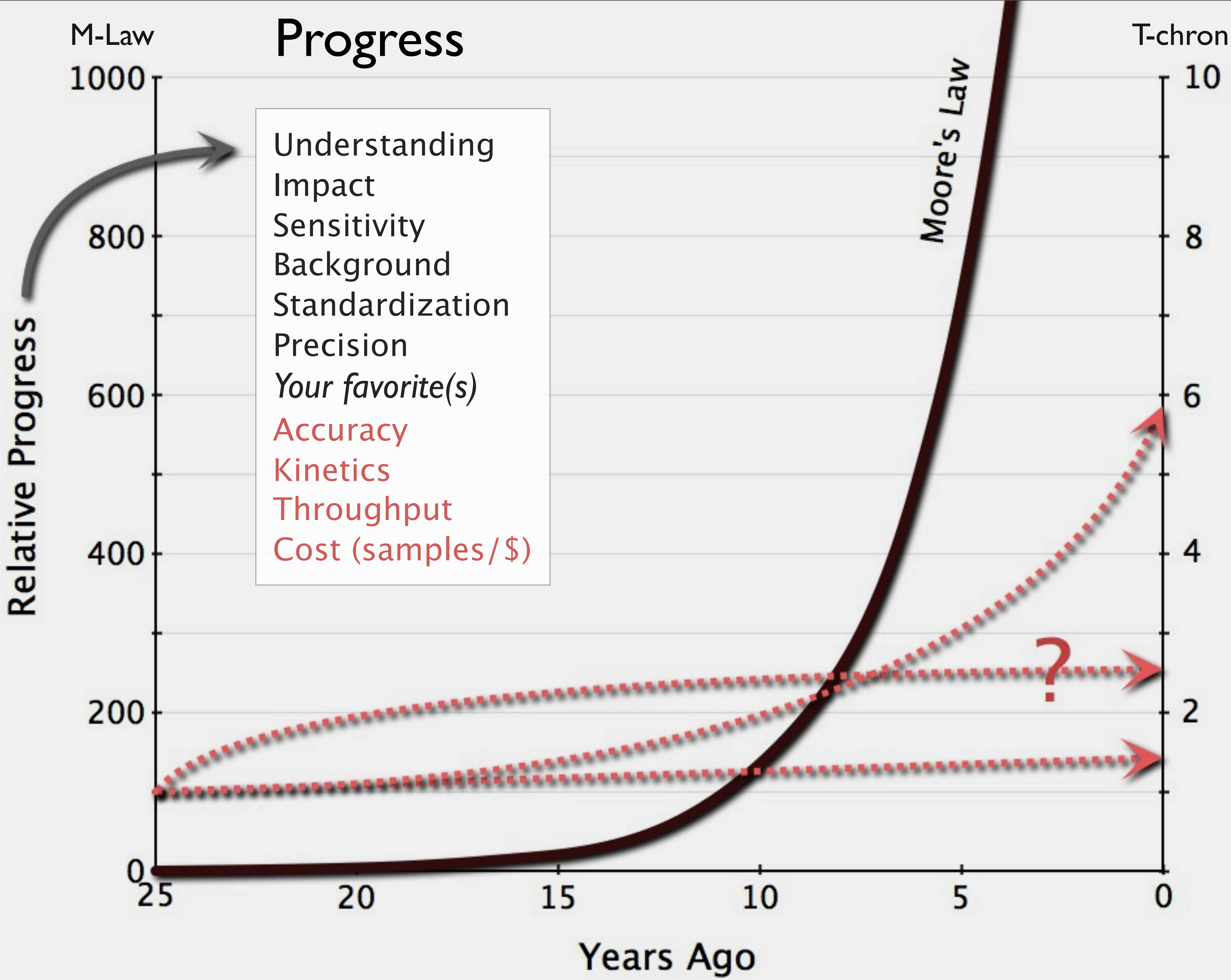


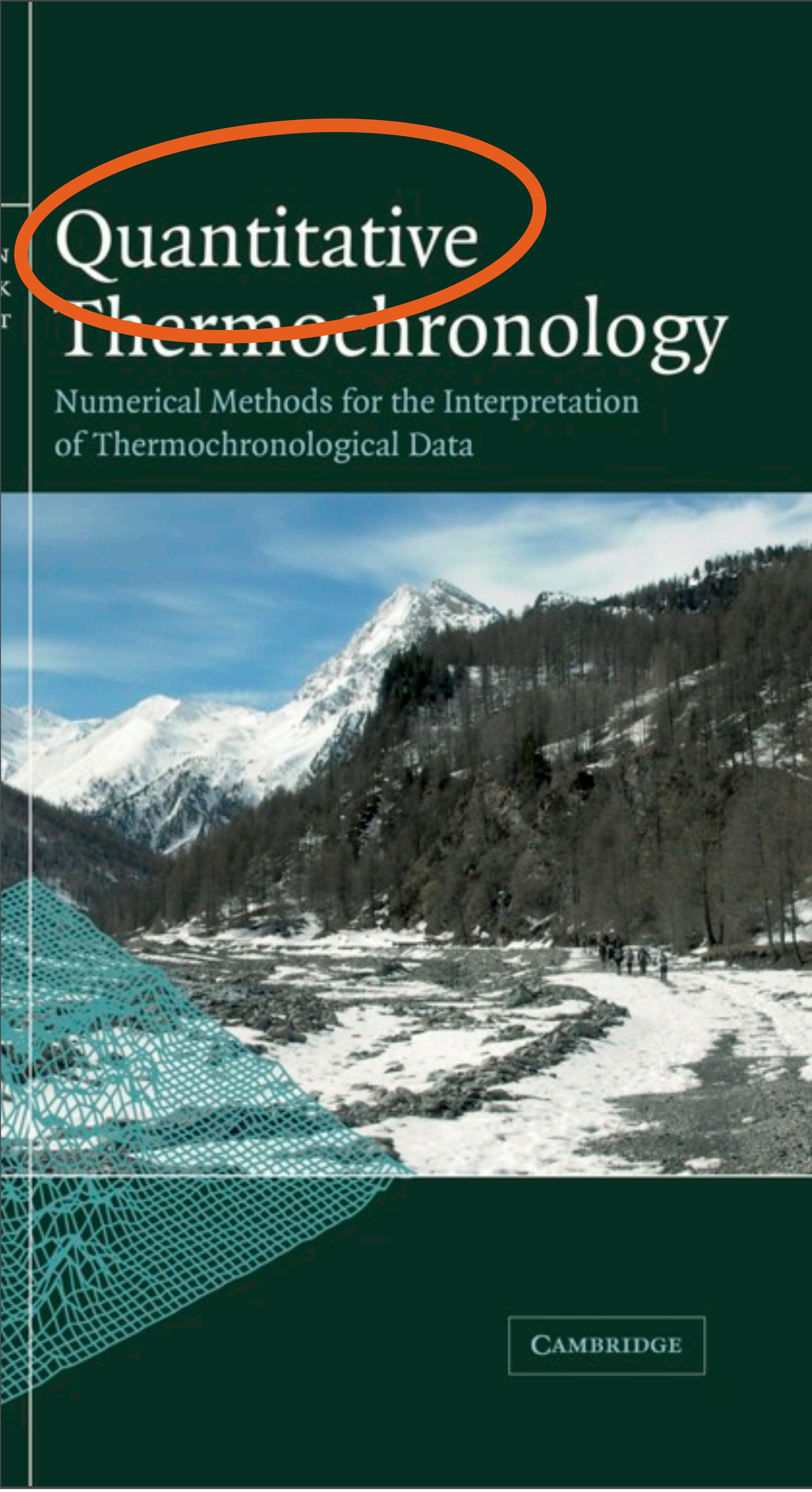
Progress



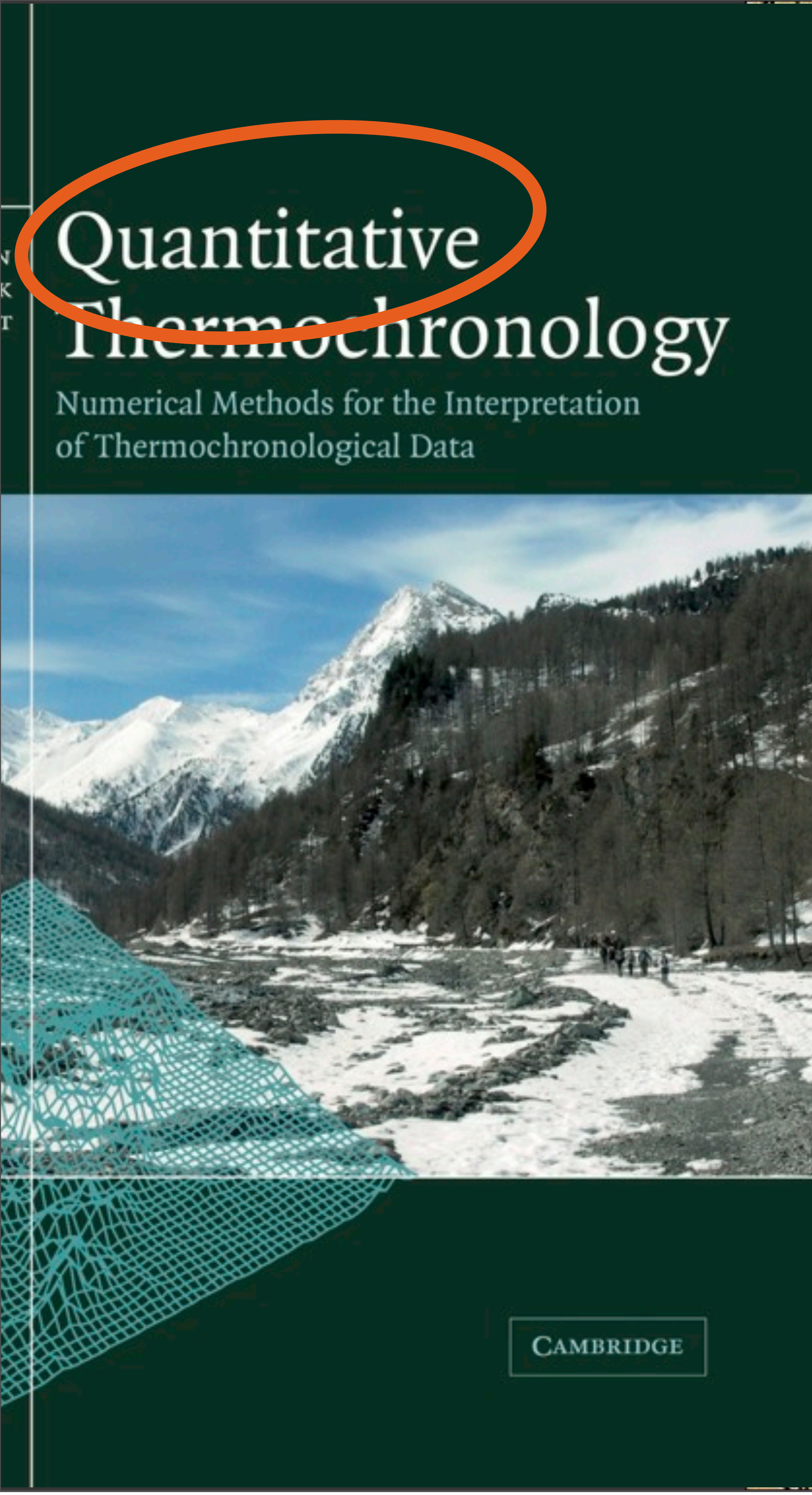
M-Law
T-chron
Understanding
Impact
Sensitivity
Background
Standardization
Precision
Your favorite(s)
Moore's Law
?
Relative Progress
Years Ago
1000
800
600
400
200
0
10
8
6
4
2
25
20
15
10
5
0

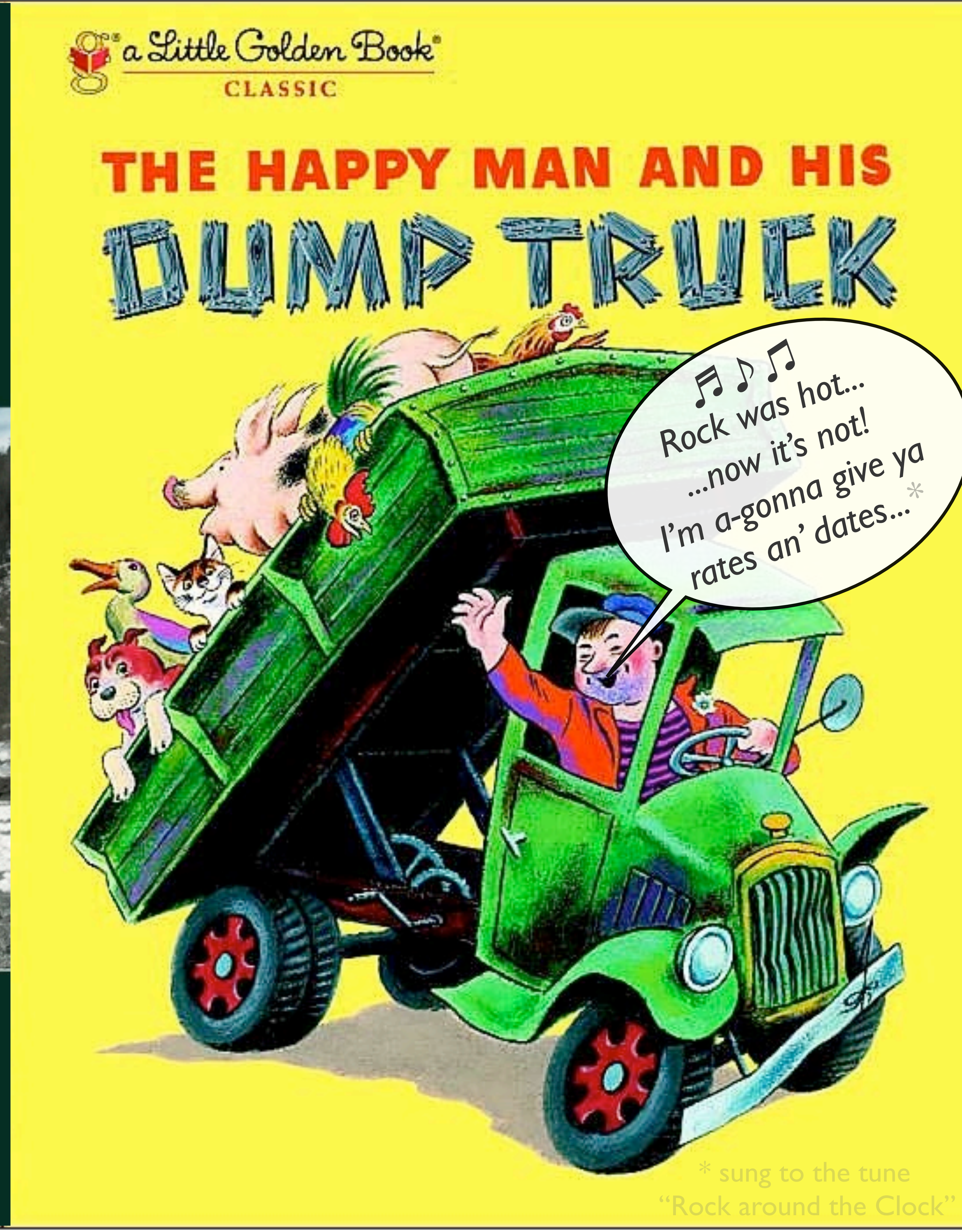
Progress


M-Law
T-chron
1000
800
600
400
200
0
10
8
6
4
2
0
Relative Progress
Understanding
Impact
Sensitivity
Background
Standardization
Precision
Your favorite(s)
Accuracy
Kinetics
Throughput
Cost (samples/$)
Moore's Law
?
25
20
15
10
5
0
Years Ago



* sung to the tune
“Rock around the Clock”

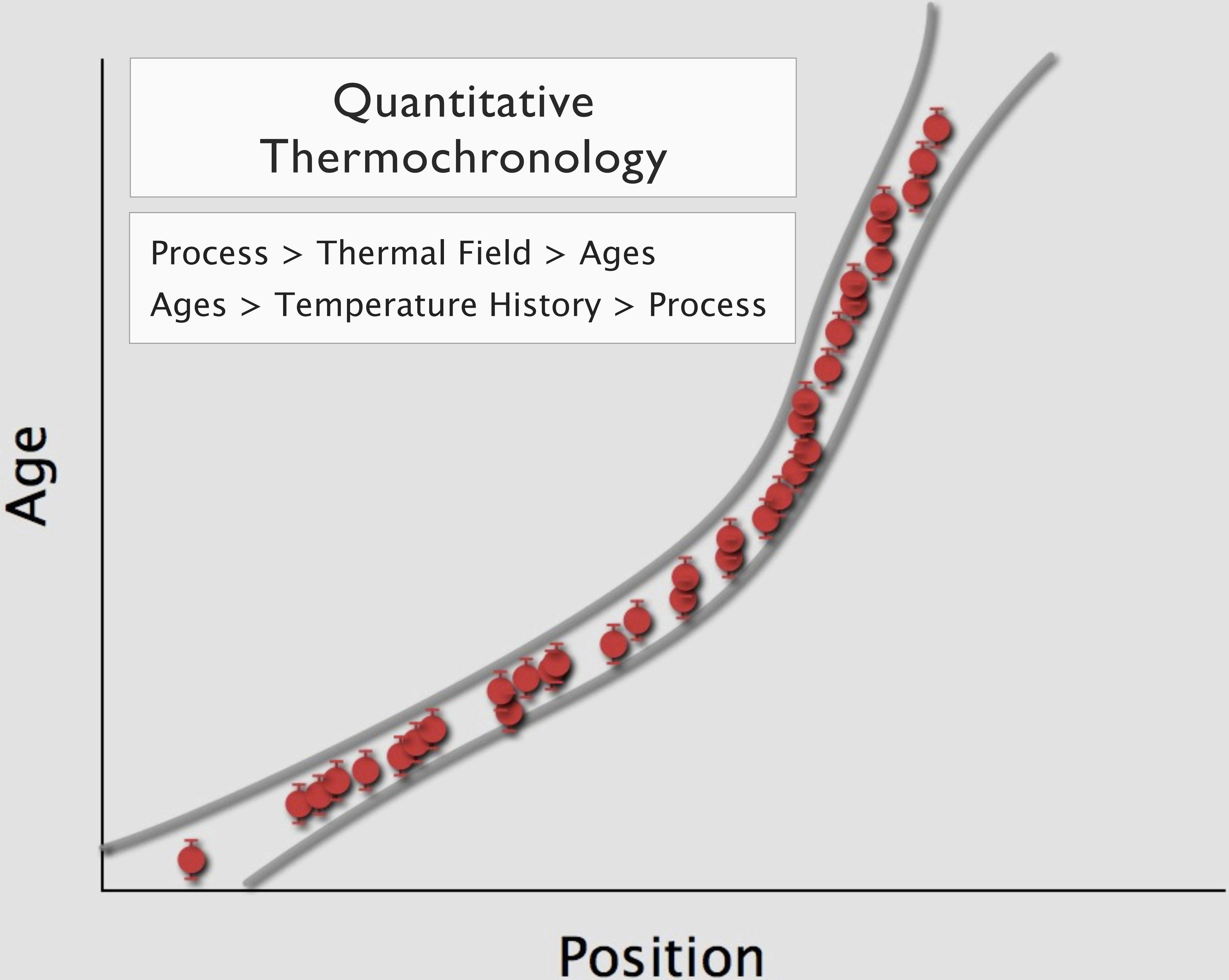

Quantitative Thermochronology
Numerical Methods for the Interpretation of Thermochronological Data
CAMBRIDGE


a Little Golden Book
CLASSIC
THE HAPPY MAN AND HIS DUMP TRUCK
Rock was hot... ...now it's not! I'm a-gonna give ya rates an' dates...*
* sung to the tune "Rock around the Clock"

Quantitative Thermochronology

Process > Thermal Field > Ages

Ages > Temperature History > Process



Quantitative Thermochronology

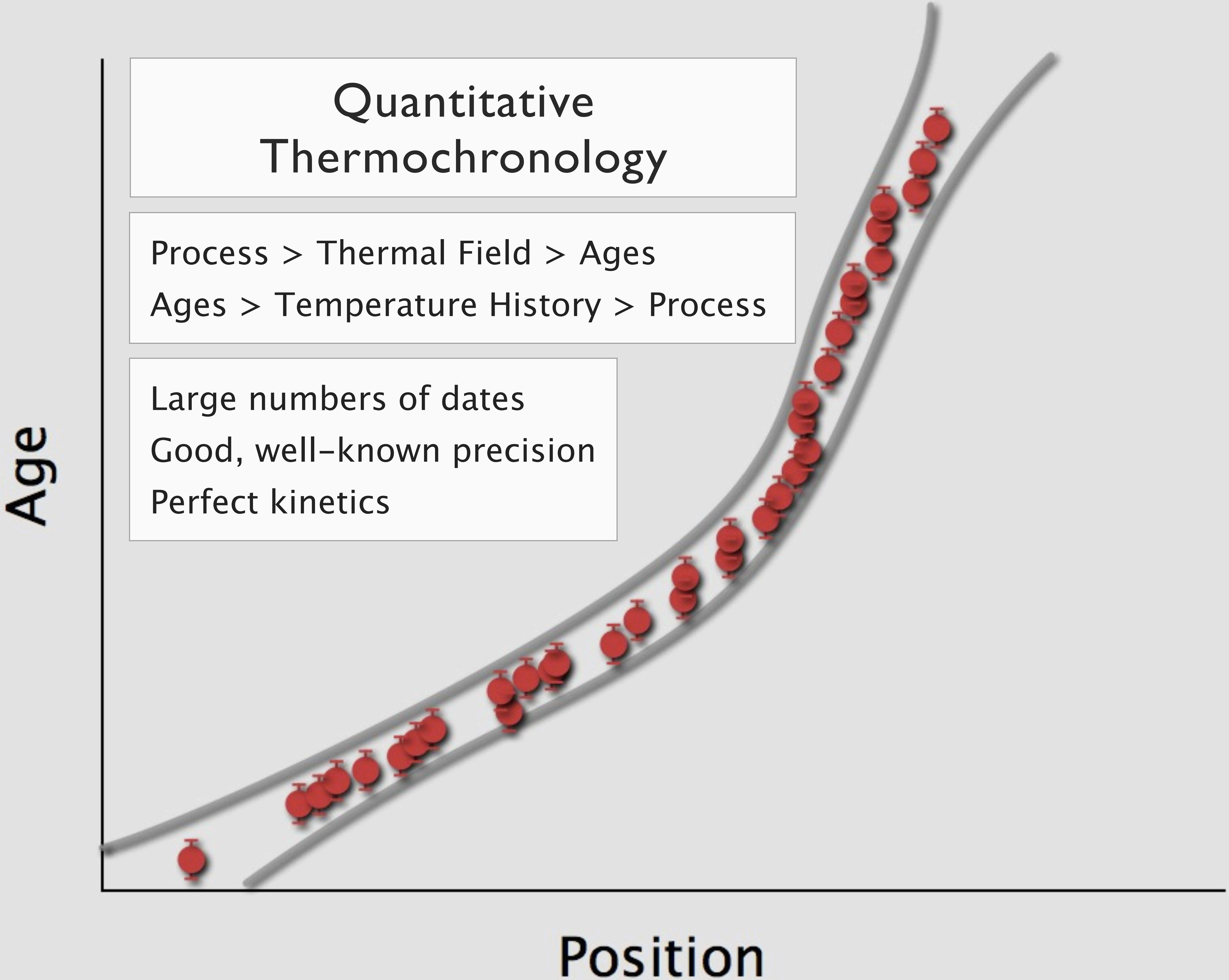
Process > Thermal Field > Ages

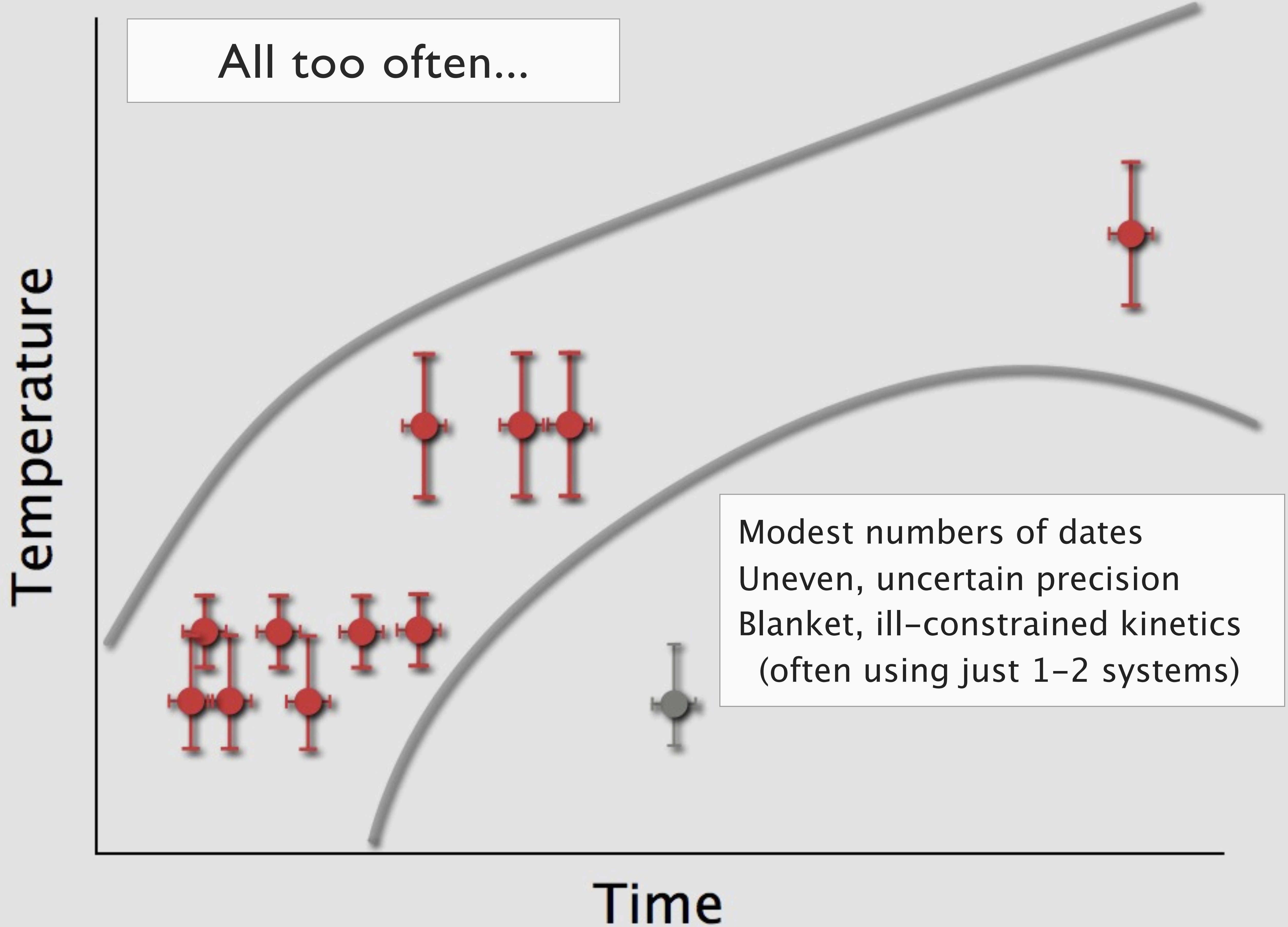
Ages > Temperature History > Process

Large numbers of dates

Good, well-known precision

Perfect kinetics




All too often...
Modest numbers of dates
Uneven, uncertain precision
Blanket, ill-constrained kinetics
(often using just 1-2 systems)
Temperature
Time

Recap

Thermochronology is a venerable and established field

It’s an enabling tool for a large and diverse user base

The glass is only fractionally full when it comes to achieving true “quantitative thermochronology”

Our penchant for curiosity-driven research is great, but successful applications pay the bills

So, what’s needed?

1. Understand Systematics

Example: *In vacuo* crushing:

Sample	Treatment or History	Fraction Released Mechanically
Durango Standard	Standard, gem quality, fast-cooled	0.5%
Young Tibetan apatite	Good actor, fast cooled	2.6%
Young Himalayan apatite	Good actor, fast cooled	2.6%
Young Himalayan apatite	Good actor, fast cooled	3.4%
Appalachian apatite	OK? actor, very slow cooled	6.4%
Appalachian apatite	Bad actor, very slow cooled	9.4%
Durango Standard	Soaked, 100 bar ^4He	16.4%
Durango Standard	Soaked, 31 bar ^4He	48.3%
Appalachian apatite	Soaked, 12.2 bar ^4He	51.9%
Young Himalayan apatite	Bad actor, fast cooled	53.1%
Appalachian apatite	Soaked, 12.2 bar ^4He	63.7%

Zeitler, Enkelmann, Thomas, Ancuta, Watson, in prep.

2. Improve Kinetics

More $^{4}He/^{3}He$ and $^{40}Ar/^{39}Ar$ MDD

Bring out the bombs! More lab kinetic studies

Kinetic standards for at least apatite and feldspar

Community agreement on kinetic values and uncertainties, an open and updating kinetic database

Standardized data protocols, error handling

3. Improve Throughput

Remember Moore's Law

Identify weak links (crushing, separation, picking, ...)
(watch an episode of "Unwrapped" on Food Network)

Cheaper and faster analysis (quadrupoles for Ar?)

Automated data-reduction workflows

Community goal: increase throughput by 10X or more

Conclusions

Keep up that creative, curiosity-driven work, but...

...Be the user

...Keep our eyes on the prize

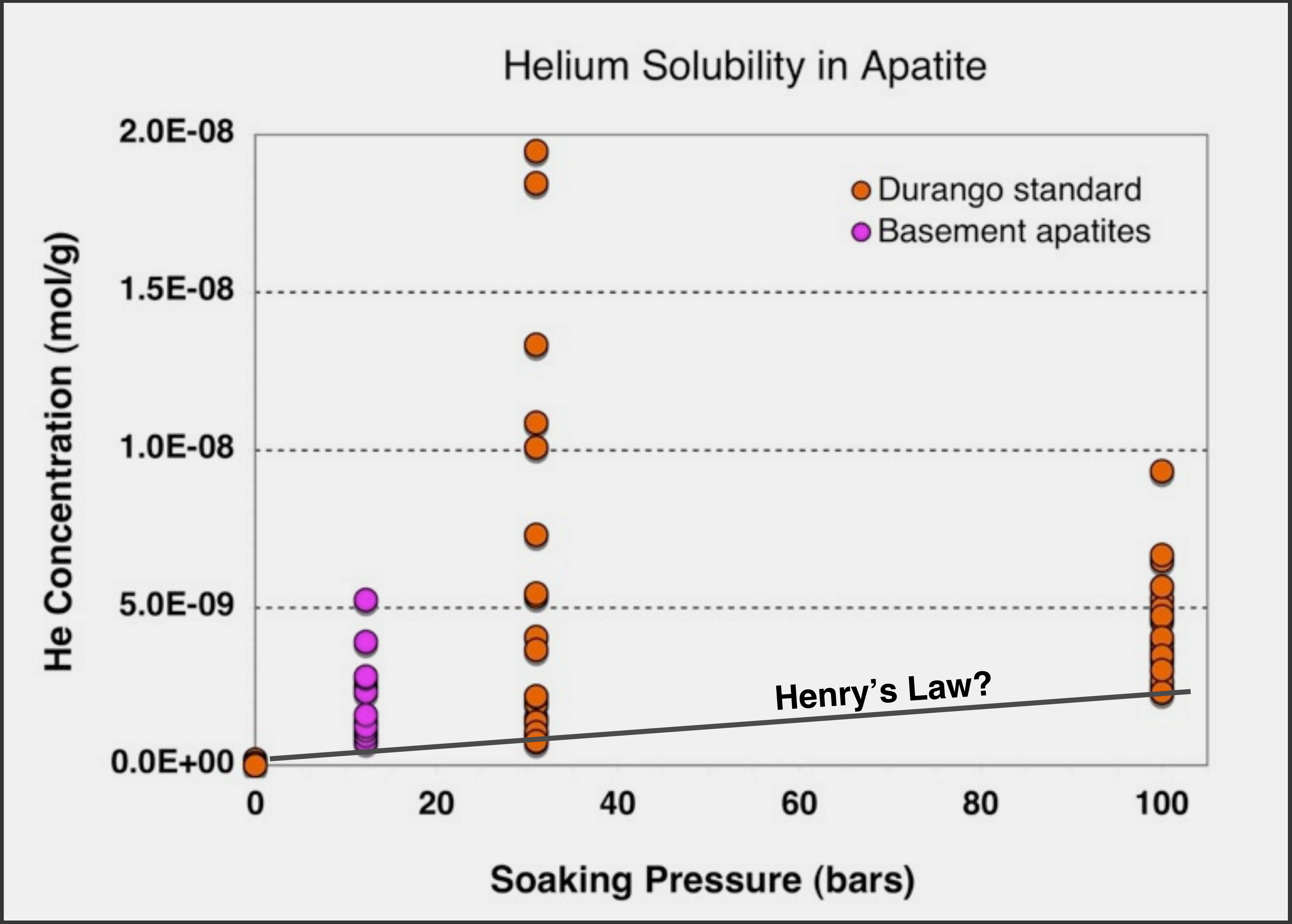
...Think bigger and more supportively as a community:

One crustal reflection profile = maybe $2,500,000

That's ~10,000 dates! What could we do with that?

1. Understand Systematics

Example:



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