



Australian Government

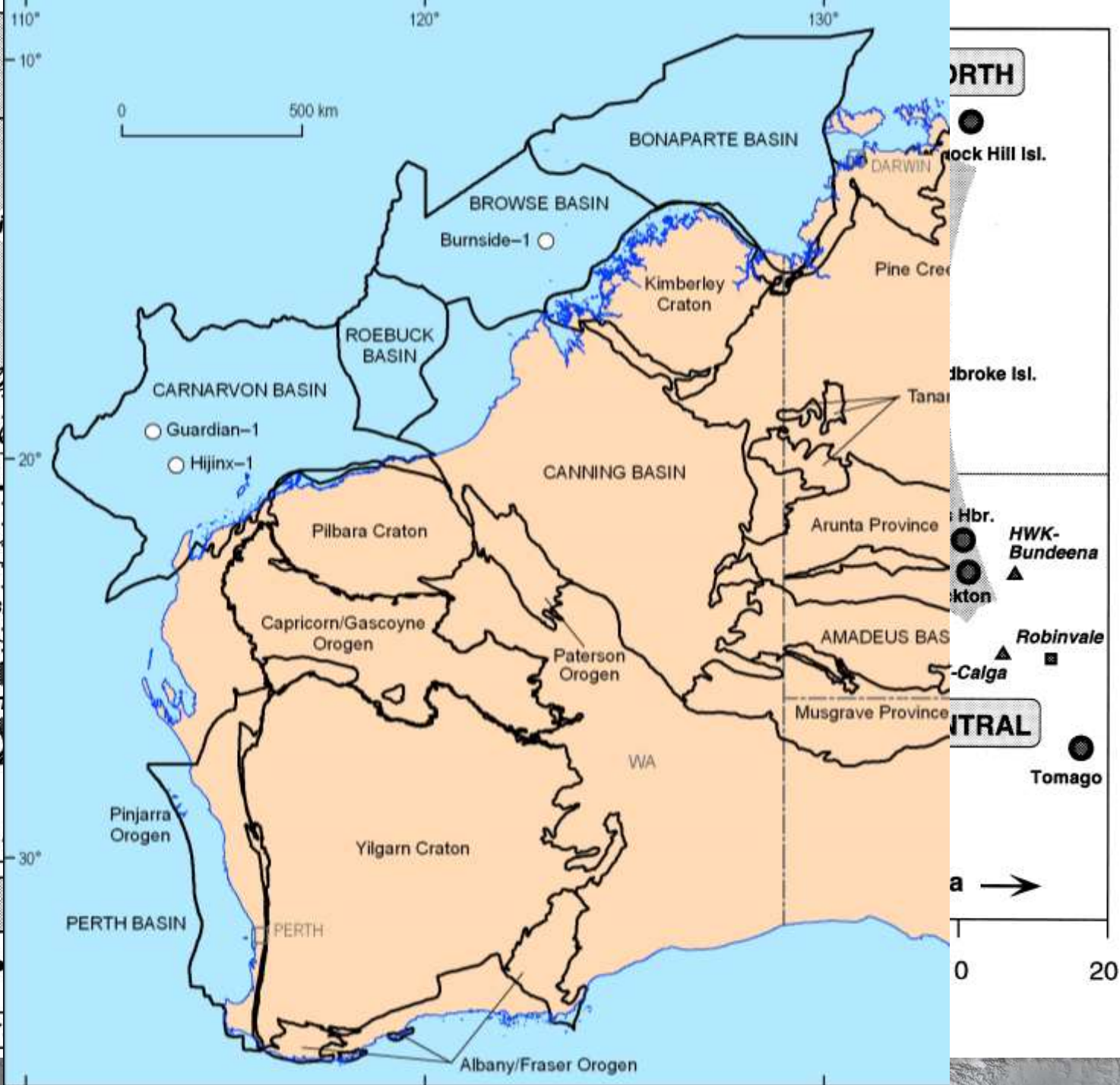
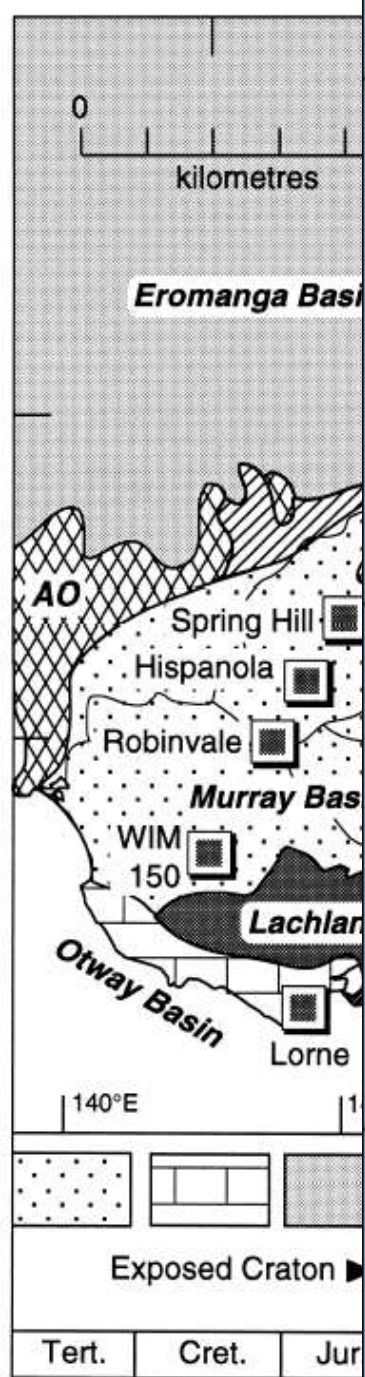
Geoscience Australia

Detrital zircon workshop: Statistics and uncertainties

Keith Sircombe

Geoscience Australia

Geochronology Laboratory



Statistics and uncertainties

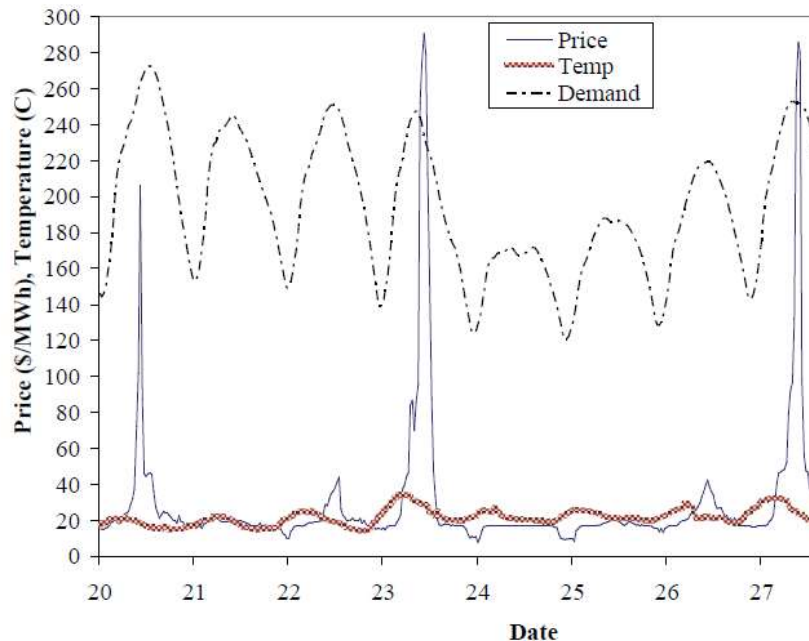
- How do you identify a population peak and quantify its age and uncertainty?
- How are the uncertainties on the defined population expressed (are they asymmetric)?
- Should we accept a 1-2% limit of the uncertainty on a defined population age until such time as we can prove we can do better?
- Should we be using Gaussian or non-Gaussian distribution statistics for these data?

A Geochronologist goes to Wollongong

A little story...

Mathematics in Industry Study Group

A sponsored workshop working on applied mathematical/statistical problems



(a) Colorbond steel coil with race-track bottom

Figure 4: Intraday temperature, load and price from 20th to

Mathematics in Industry Study Group

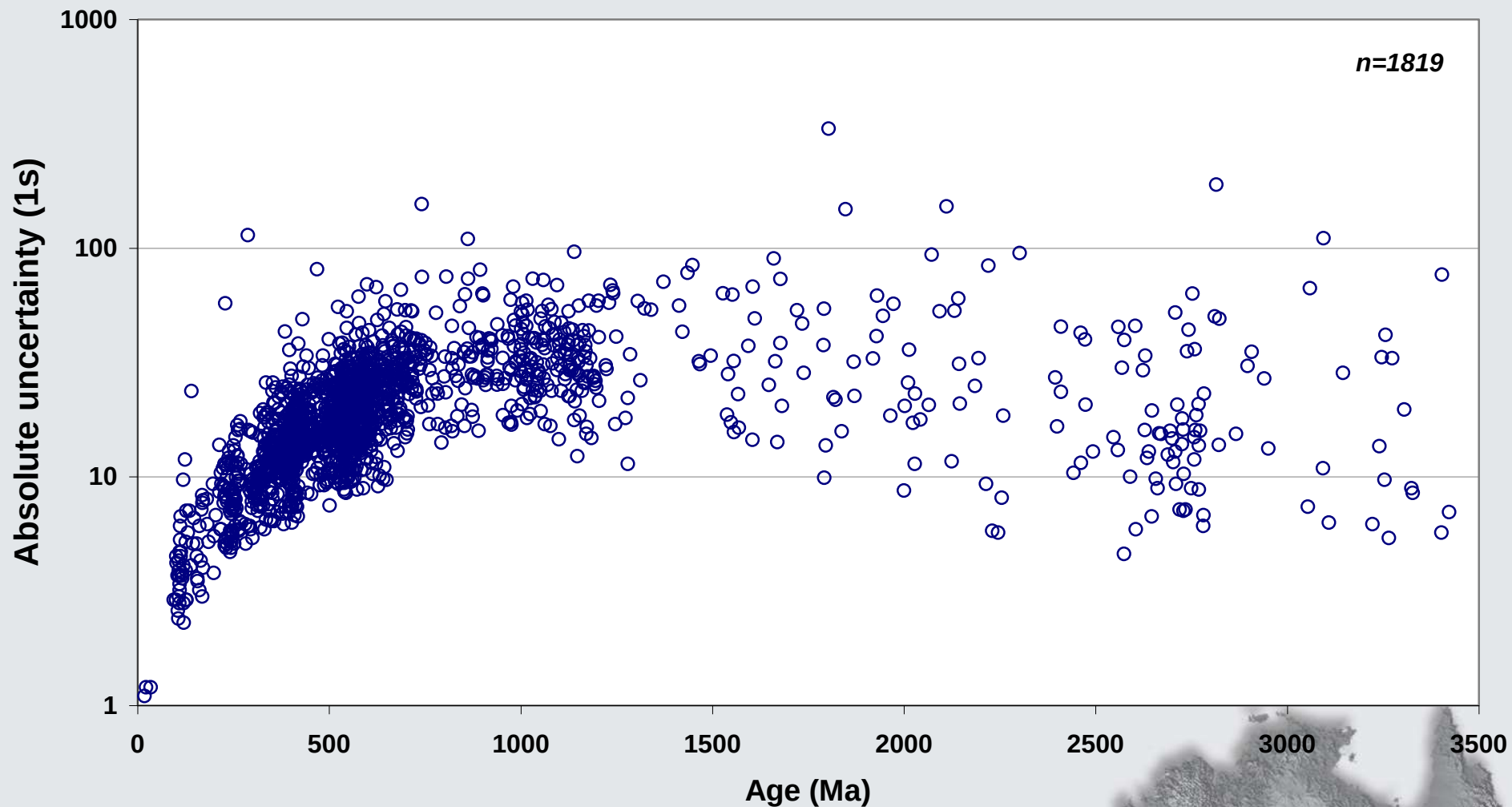
And they asked:

“How do you measure the age of a zircon?”

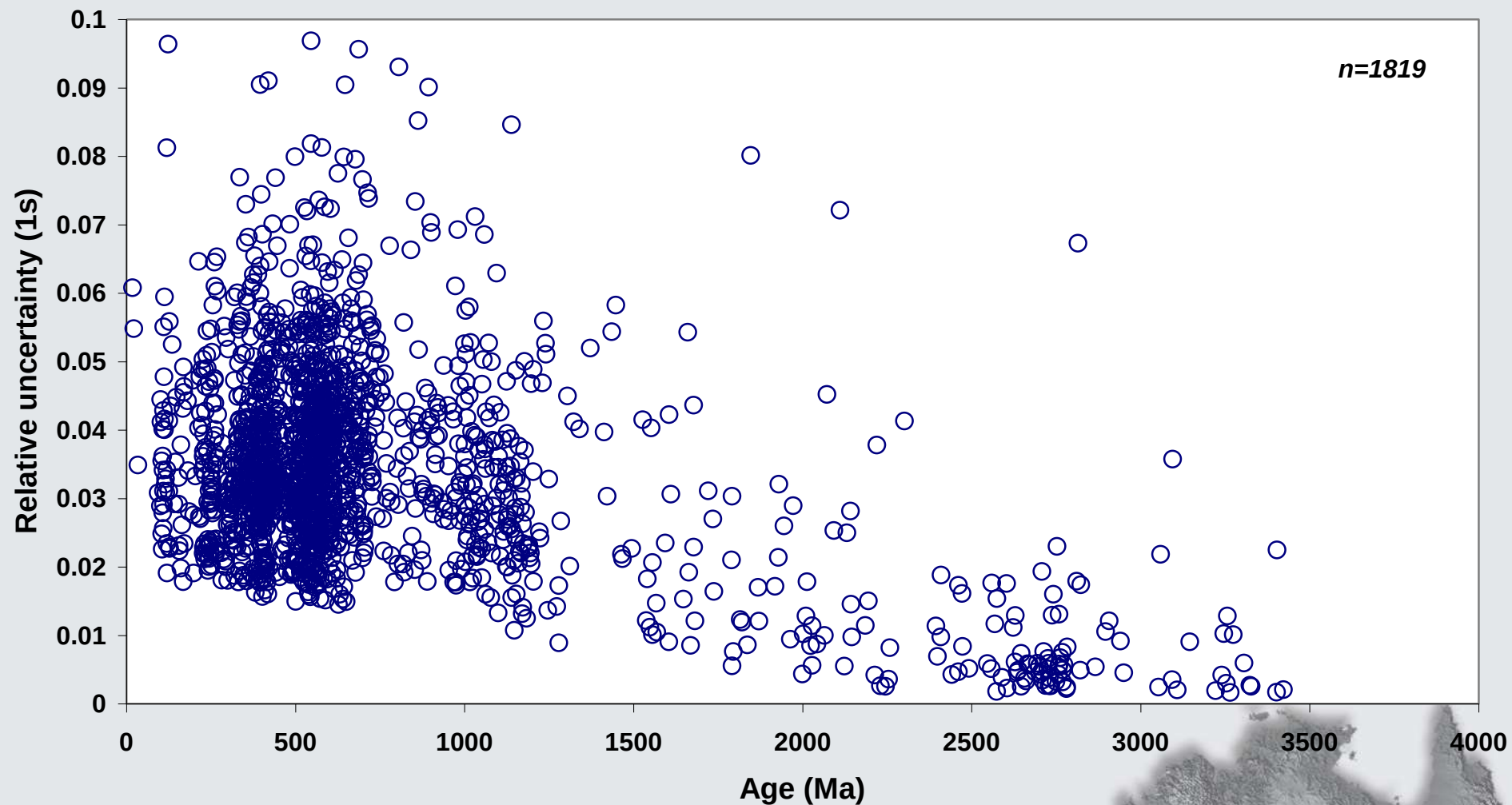
Which led to a great day explaining
radioactive decay, ionisation potentials,
calibration references and sedimentology...

But my brain started hurting when they
said: “Heteroscedastic Measurement Error”

Australian Detrital Zircon dataset



Australian Detrital Zircon dataset



Provenance of sedimentary rocks

Geoffrey Pritchard
University of Auckland

Paul Moloney
RMIT

Ken Russell
University of Wollongong

Bill Whiten
University of Queensland

Abstract

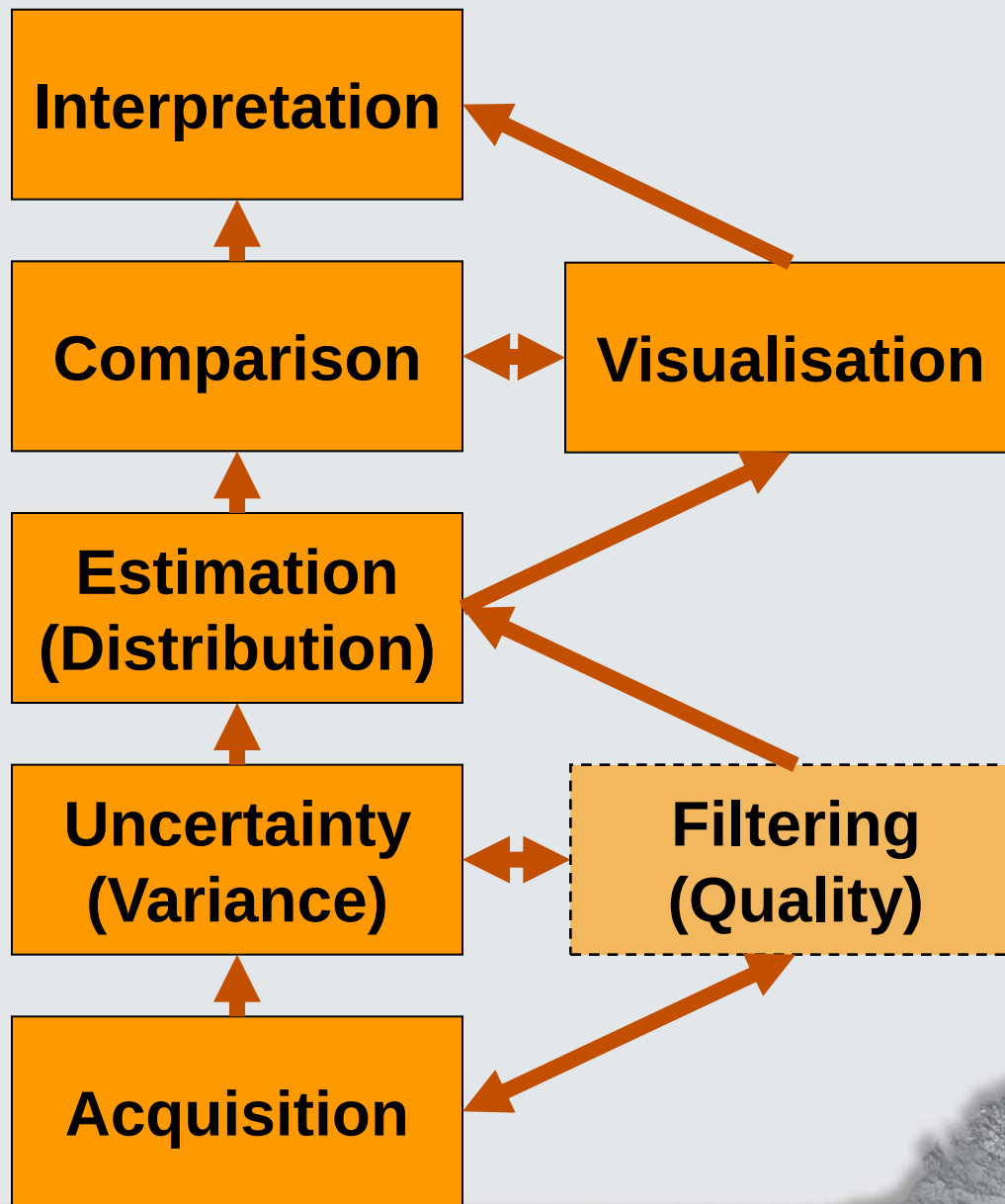
Understanding the origins, or provenance, of a sedimentary deposit is an important aspect of geology. Sedimentary rocks are derived from the erosion of other rocks and thus provide important records of the geological environment at the time they were deposited. Some minerals found in sedimentary rocks, such as zircon particles, can be dated using uranium-lead techniques to trace the age of their parent rock thus providing useful information about the geological environment.

Statistical and mathematical analyses that can assist in the analysis of the distribution of ages of the zircon crystals are examined. Methods of defining a difference between the distributions of ages found in rock samples are proposed, and demonstrated in the division of multiple rock samples into clusters of similar types.

A test for the existence of a cluster is developed, and statistics for comparing different rock samples examined. Estimating an accurate age for the sedimentary deposit itself proves to be difficult unless prior distributions providing significant extra information are available.

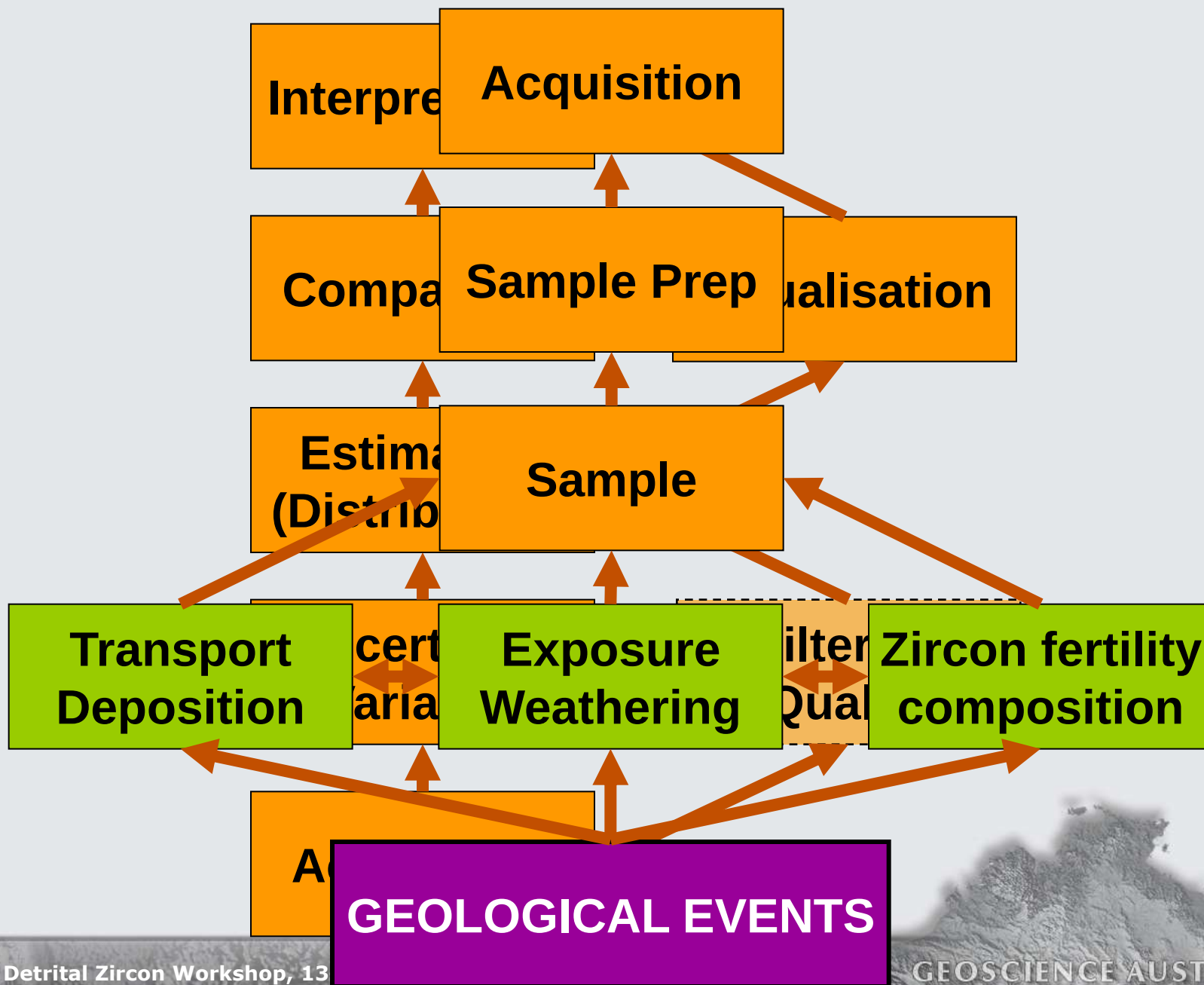
MISG take home message:

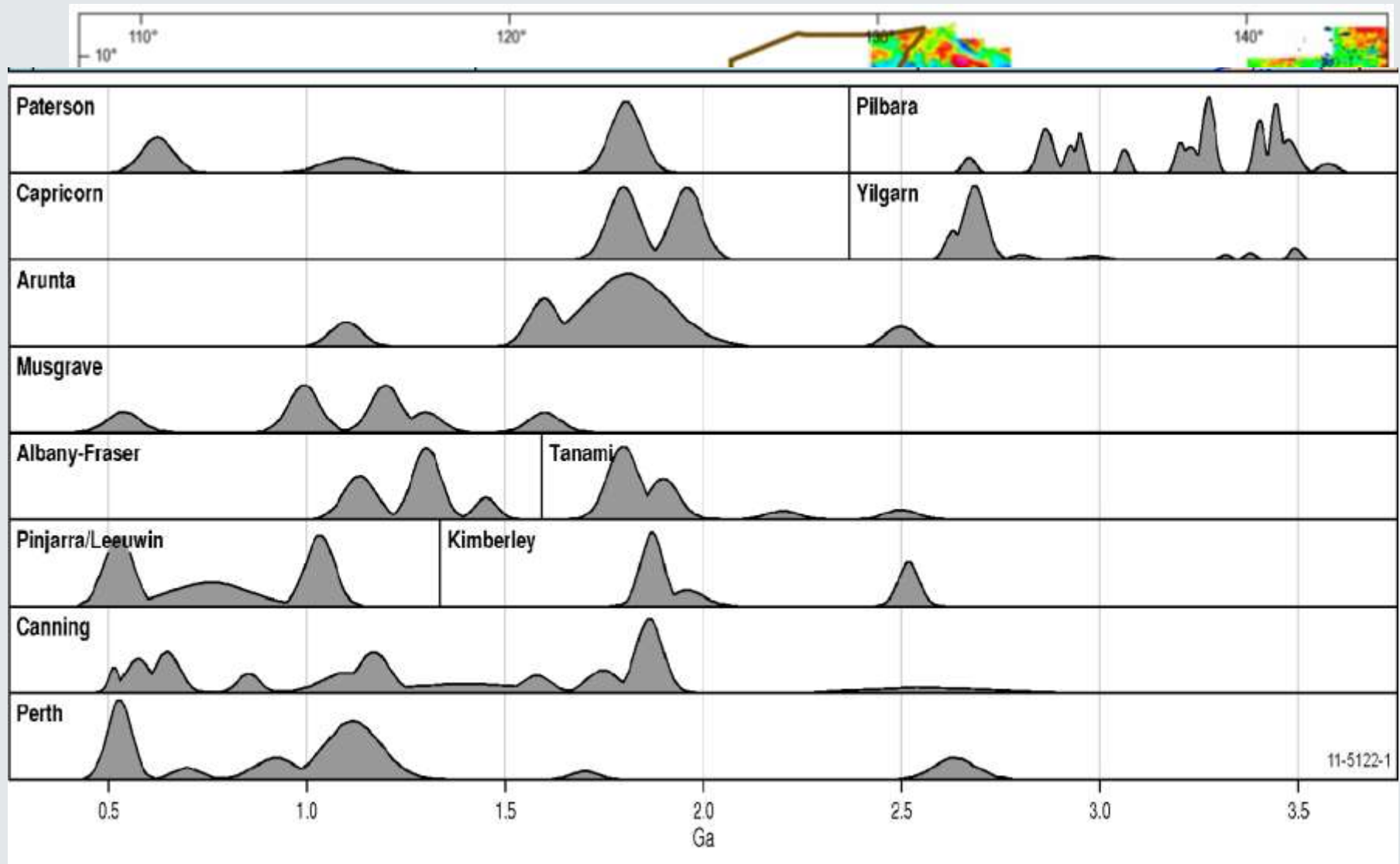
- There are no silver statistical bullets:
 - there is a lot of work to do
 - achievable: plan and communicate
- We may be starting at the wrong end of the analytical process... understanding the way the data are acquired is critical for knowing how to use it
- Also links strongly to data management



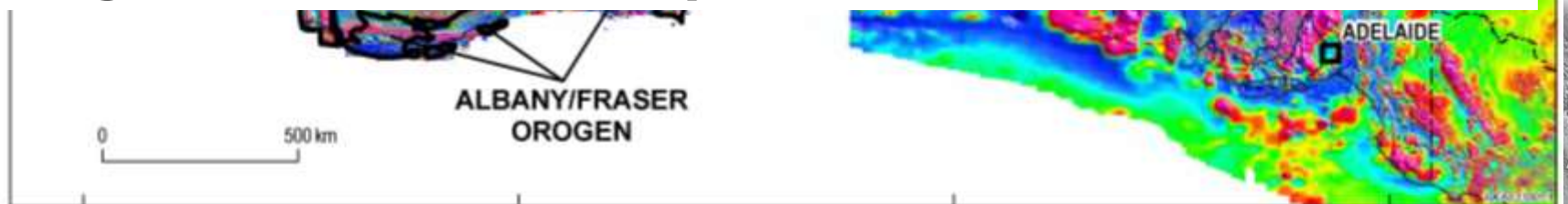
Statistics and uncertainties

- How do you identify a **population** peak and quantify its age and uncertainty?
- How are the uncertainties on the defined **population** expressed (are they asymmetric)?
- Should we accept a 1-2% limit of the uncertainty on a defined **population** age until such time as we can prove we can do better?
- Should we be using Gaussian or non-Gaussian distribution statistics for these data?





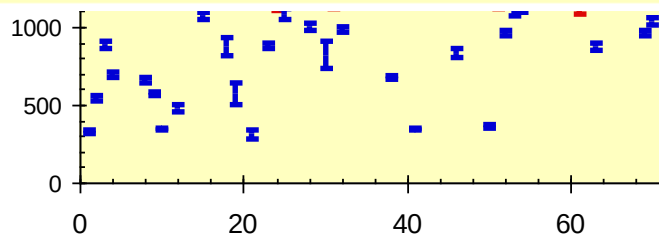
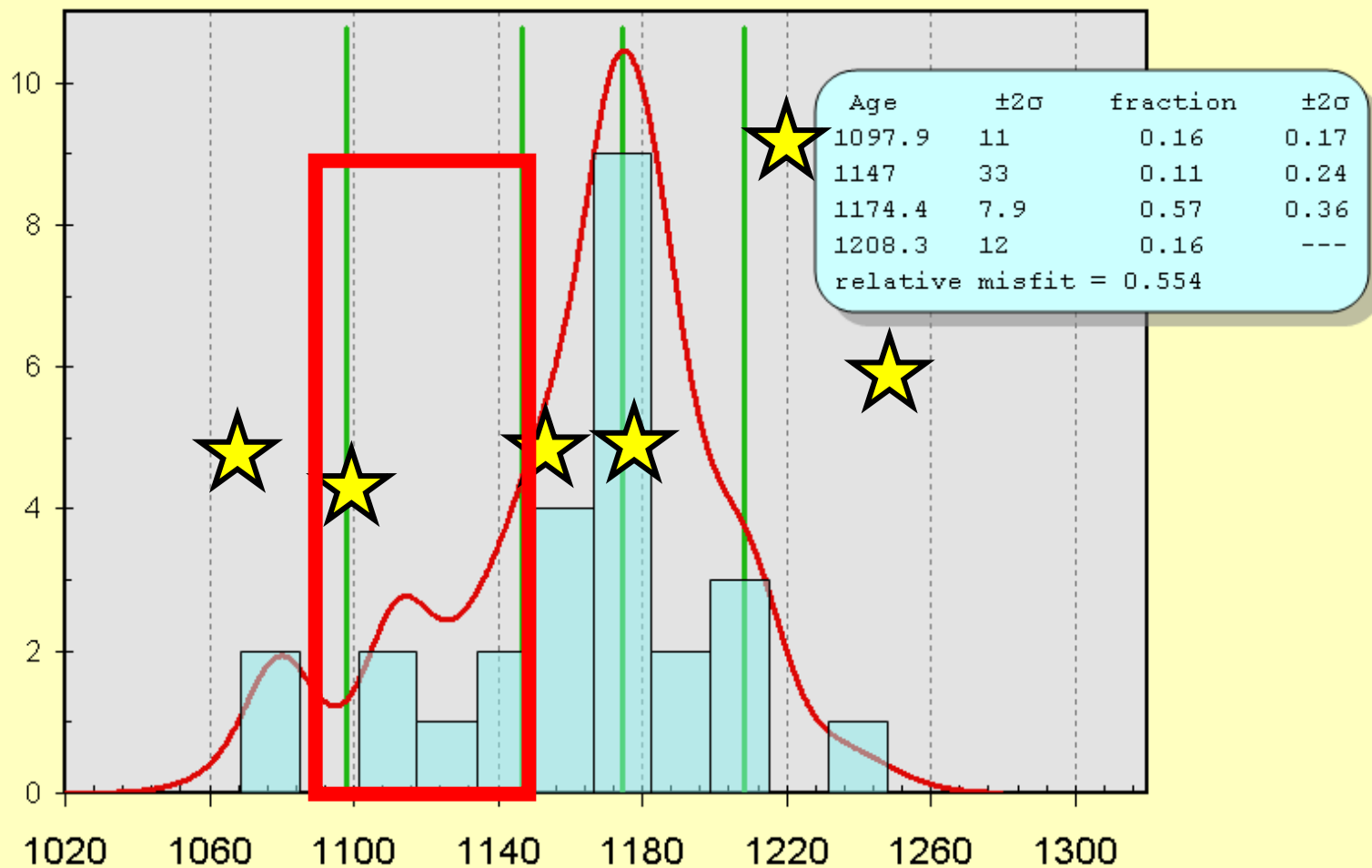
Geological events are not symmetrical and well ordered...



How do you identify a population peak and quantify its age and uncertainty?

- Eyeball (maxima)
- 'MSWD clustering': weighted mean
- Mixture modelling
- (MISG cluster determination)

$$\frac{x(n-k+1)^{1/(k-1)} \int_0^1 t^{k-2} (1-t)^{n-k+1} dt}{\int_0^1 t^{k-2} (1-t)^{n-k+1} dt}$$



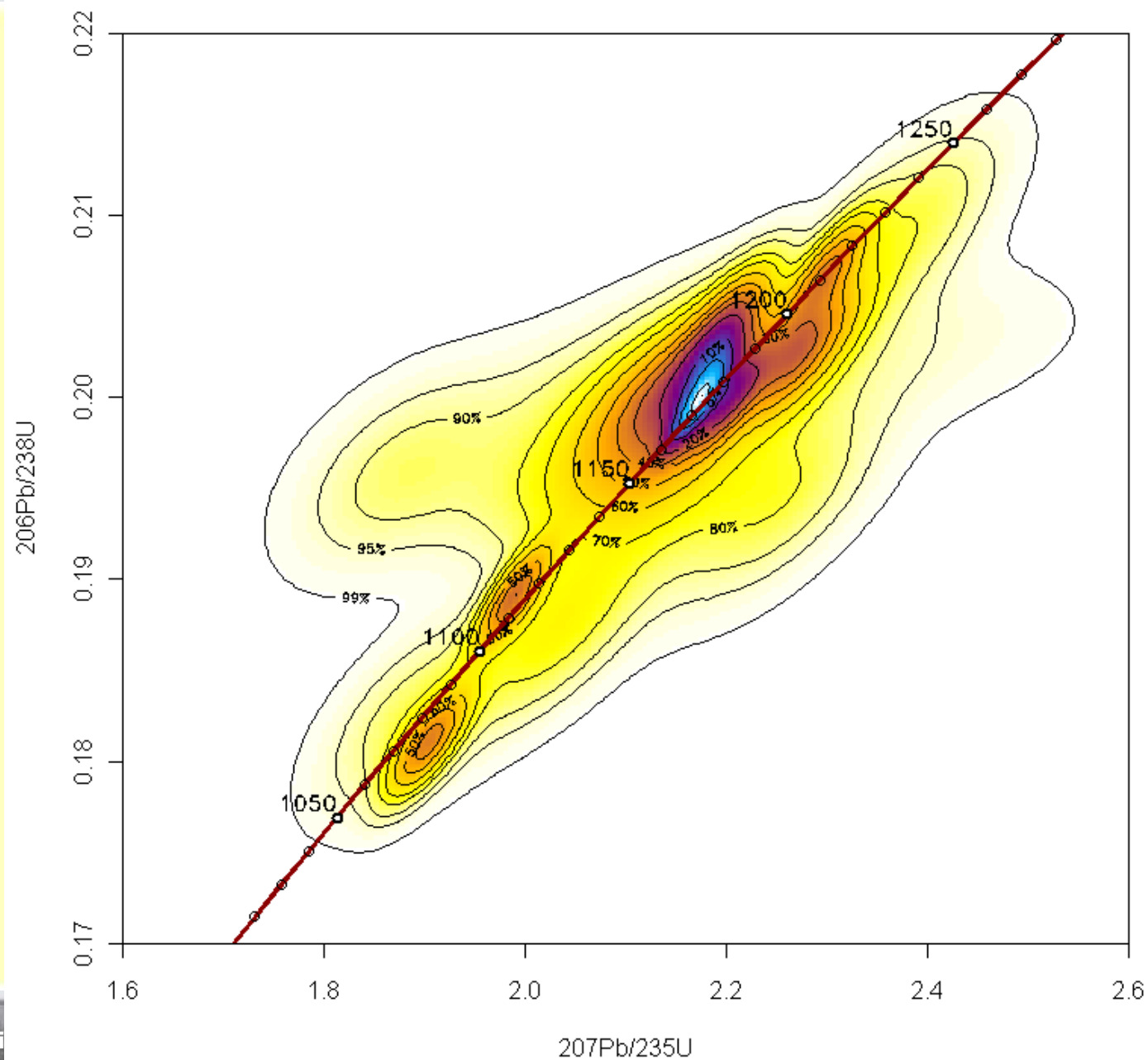
Probability

0.08

age error (95% conf., with error in Std)

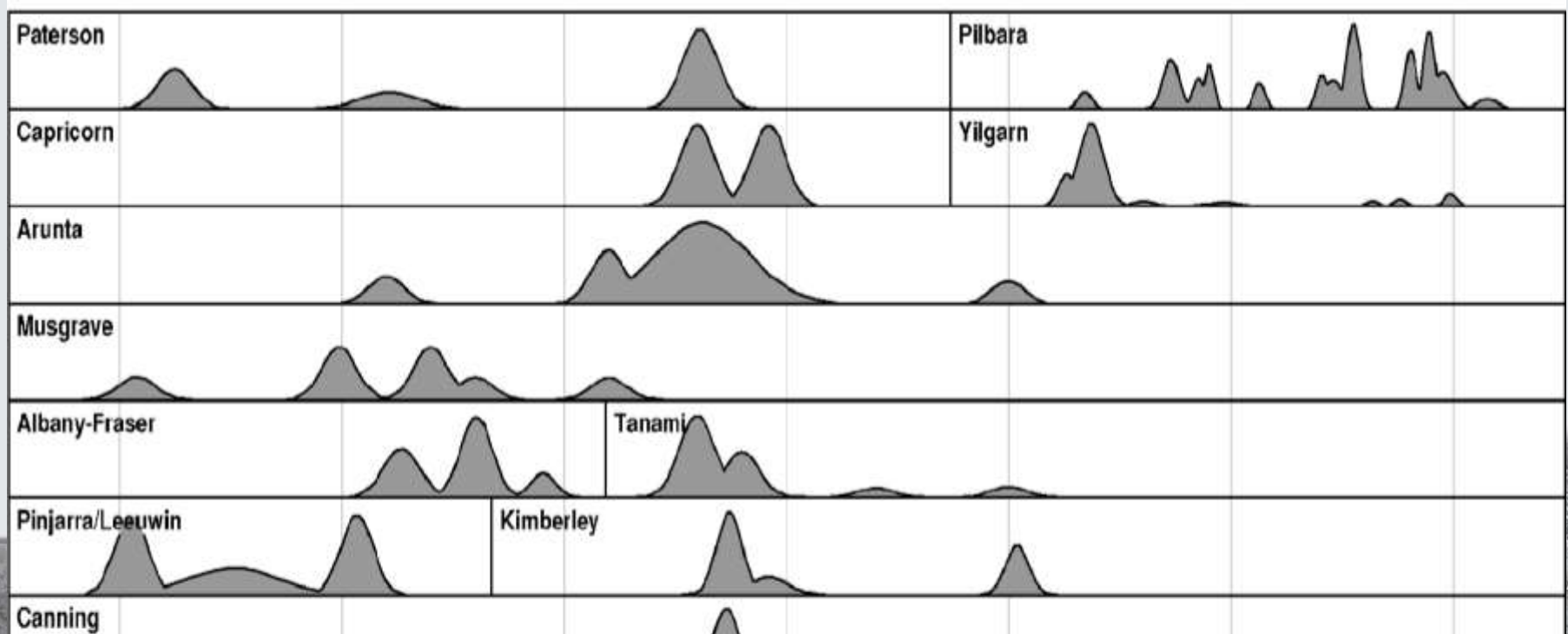
8.0

2002617 part



How are the uncertainties on the defined population expressed (are they asymmetric)?

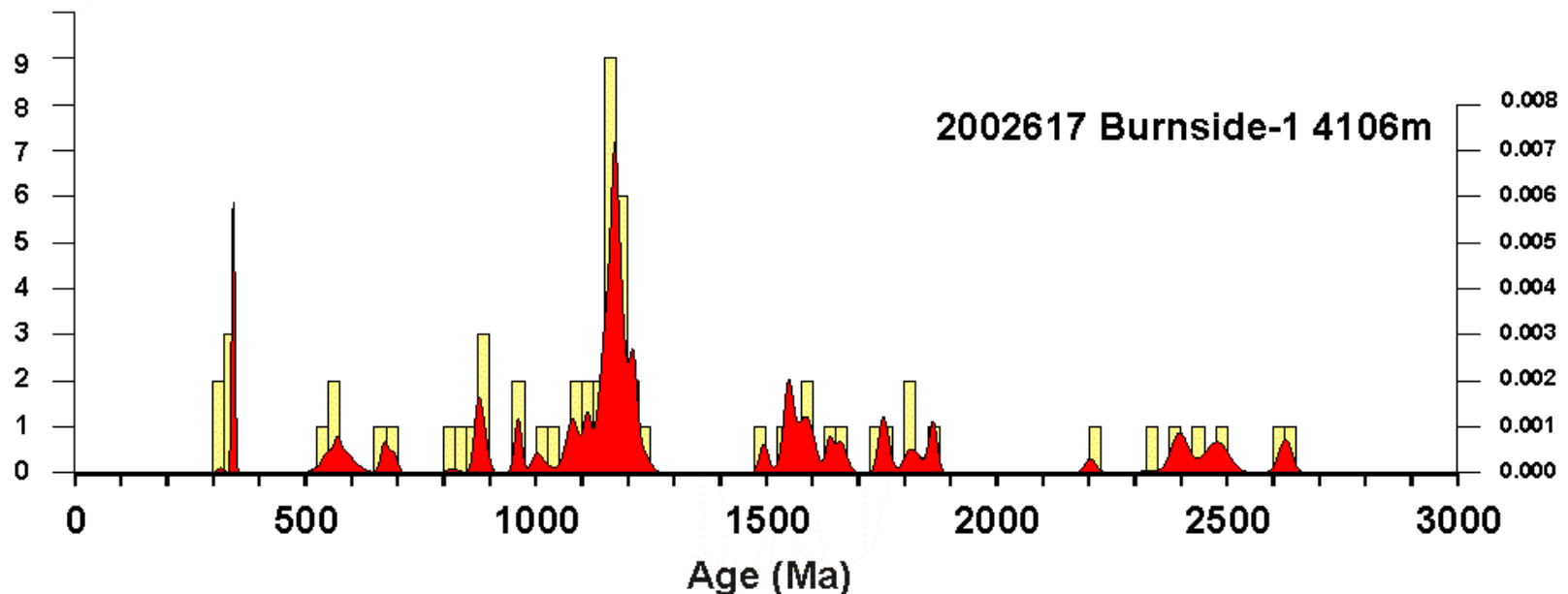
Should we be using Gaussian or non-Gaussian distribution statistics for these data?



Should we accept a 1-2% limit of the uncertainty in the refined population age until we can prove we can do better?

Interpretation

- Yes. **Ask the Astronomers?**



Discuss...