INITIAL RESULTS OF THE ZIRCON REFERENCE SET 'OFF-SET PLOT' EXPERIMENT

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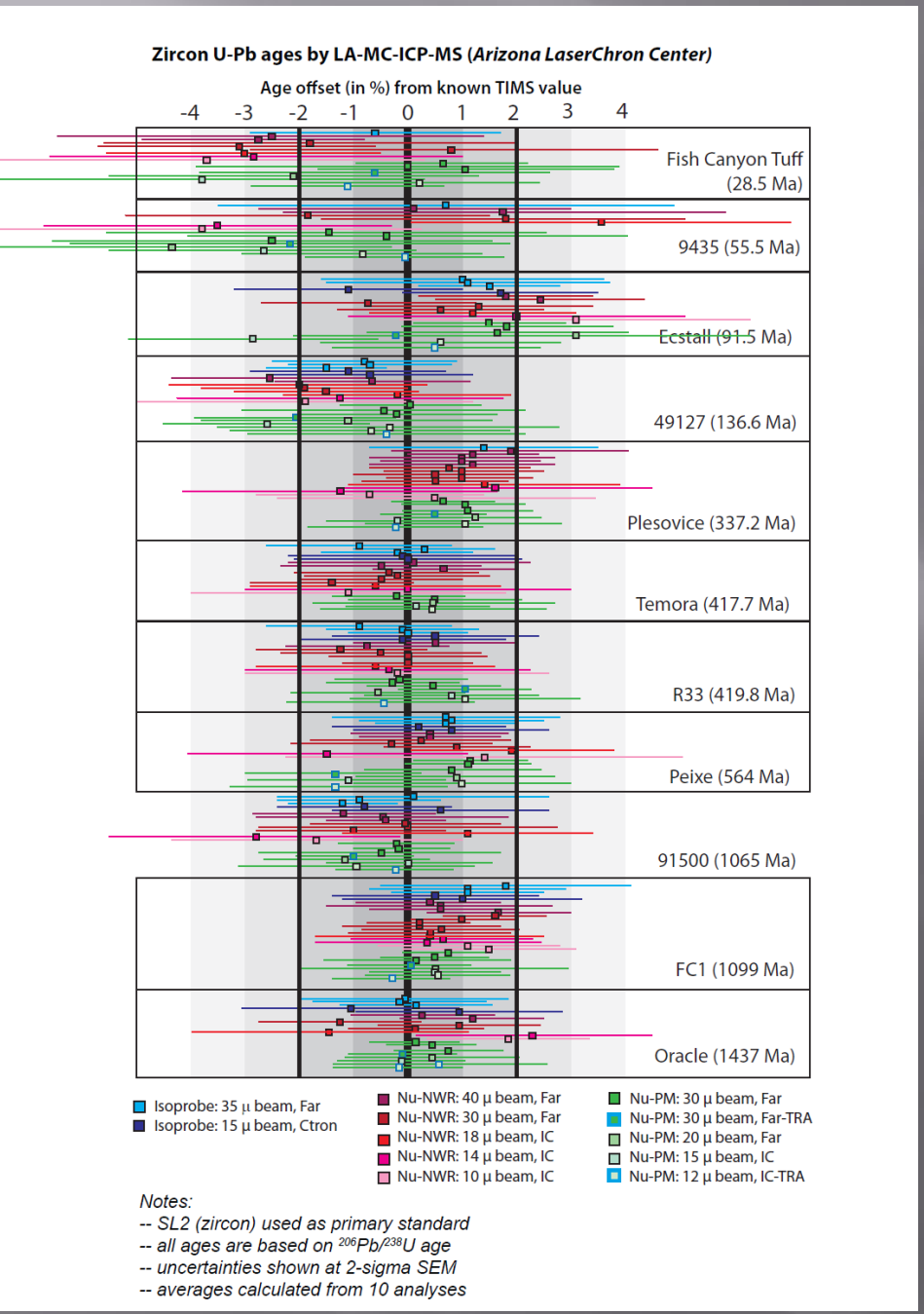
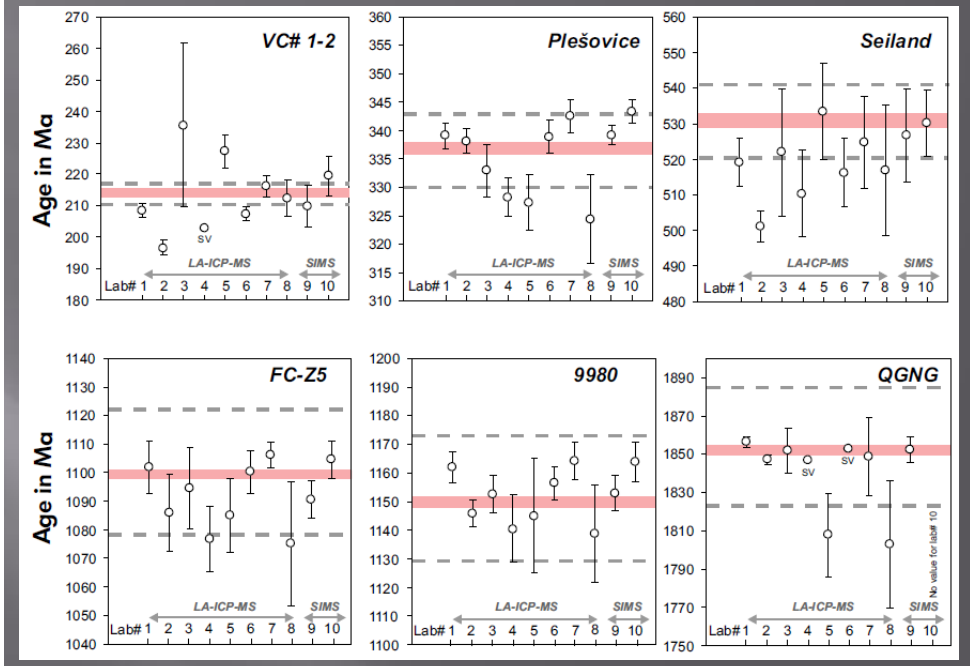
Examples…


Zircon U-Pb ages by LA-MC-ICP-MS (Arizona LaserChron Center)
Age offset (in %) from known TIMS value
-4 -3 -2 -1 0 1 2 3 4
Fish Canyon Tuff (28.5 Ma)
9435 (55.5 Ma)
Ecstall (91.5 Ma)
49127 (136.6 Ma)
Plesovice (337.2 Ma)
Temora (417.7 Ma)
R33 (419.8 Ma)
Peixe (564 Ma)
91500 (1065 Ma)
FC1 (1099 Ma)
Oracle (1437 Ma)
Isoprobe: 35 µ beam, Far
Isoprobe: 15 µ beam, Ctron
Nu-NWR: 40 µ beam, Far
Nu-NWR: 30 µ beam, Far
Nu-NWR: 18 µ beam, IC
Nu-NWR: 14 µ beam, IC
Nu-NWR: 10 µ beam, IC
Nu-PM: 30 µ beam, Far
Nu-PM: 30 µ beam, Far-TRA
Nu-PM: 20 µ beam, Far
Nu-PM: 15 µ beam, IC
Nu-PM: 12 µ beam, IC-TRA
Notes:
-- SL2 (zircon) used as primary standard
-- all ages are based on 206Pb/238U age
-- uncertainties shown at 2-sigma SEM
-- averages calculated from 10 analyses


VC# 1-2
Plešovice
Seiland
FC-Z5
9980
QGNG
Age in Ma
Lab# 1 2 3 4 5 6 7 8 9 10
LA-ICP-MS
SIMS
SV

Goals

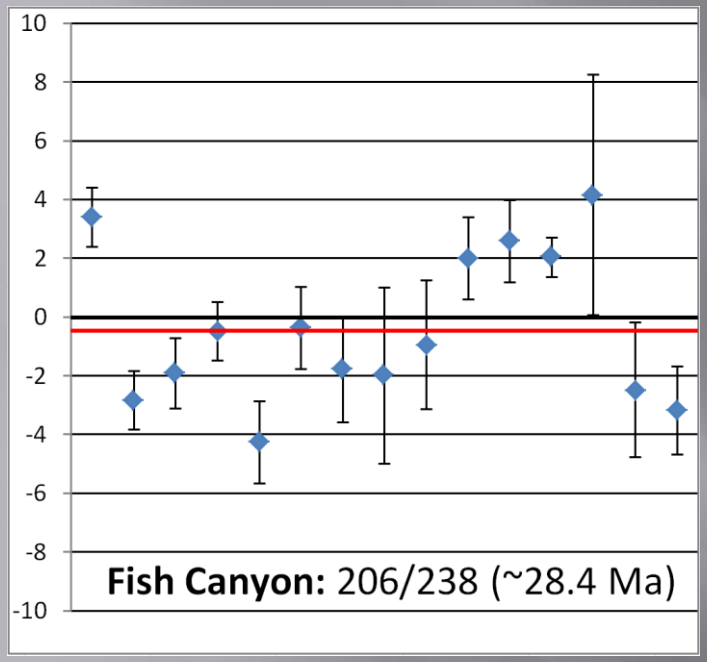
- Systematic offsets/biases seen in data sets. Do we all see the same biases?
- Need to quantify the long term variance for each lab – systematic error component in age uncertainty
- Used current methods, primary standards, and data reduction, so results should be representative of currently published data

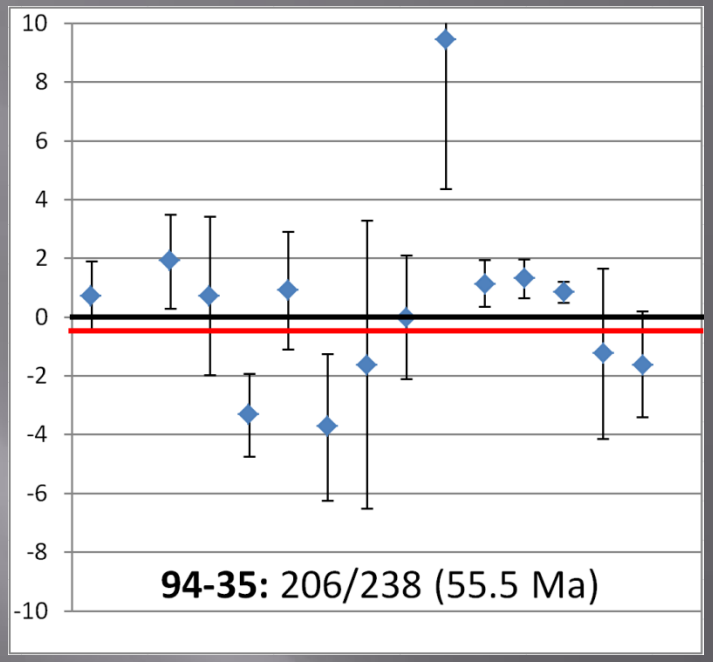
Samples Provided

- Materials sourced; 10 samples, 100 packets of each, 100 grains in each packet (= 100,000 grains picked!)
- Sent to 46 labs, 10 responses…..
- Results compiled (recently!)
- Measured ages referenced to CA-TIMS values (black lines)
- Added red lines to show zero offset from the non-CA ages
- Results are weighted mean +/-2σ uncertainties for each set
- Most labs did not report separate systematic uncertainties!

Compiled CA & non-CA ages
(www.laserchron.org)

Sample	$^{206}Pb^*/^{238}U$ Age (Ma, ± 2σ)	$^{206}Pb^*/^{207}Pb^*$ Age (Ma, ± 2σ)	Technique (ID-TIMS, CA-TIMS)	Material	Publication for age
Fish Canyon	28.478 ± 0.024	NA	ID-TIMS	small crystals	Schmitz and Bowring (2001), Geochimica et Cosmochimica Acta, v. 65, no. 15, p. 2571-2587
Fish Canyon	28.61 ± 0.08	NA	CA-TIMS	small crystals	Bachman et al. (2007), Chemical Geology, v. 236, p. 134-166
94-35	55.5 ± 1.5	NA	ID-TIMS	small to large crystals	Klepeis et al. (1998) Journal of Structural Geology, v. 20, p. 883-904. CA-TIMS analyses in progress at MIT....
Plesovice	337.1 ± 0.2	339.3 ± 0.3	CA-TIMS	moderate-size crystals	Slama et al. (2008) Chem. Geol., v. 249, p. 1-35. Assigned ages from Horstwood et al. (2014): in prep.
Temora-2	416.78 ± 0.33	NA	ID-TIMS	small crystals	Black et al. (2004) Chem. Geol., v. 205, p. 115-140.
Temora-2	418.37 ± 0.14	420.13 ± 0.30	CA-TIMS	small crystals	Mattinson (2010) Chem. Geol., v. 275, p. 186-198.
R33	419.3 ± 0.4	NA	ID-TIMS	small crystals	Black et al. (2004) Chem. Geol., v. 205, p. 115-140.
R33	420.53 ± 0.16	422.37 ± 0.36	CA-TIMS	small crystals	Mattinson (2010) Chem. Geol., v. 275, p. 186-198.
91500	1062.4 ± 1.9	1065.4 ± 0.5	ID-TIMS	single crystal	Wiedenbeck et al. (1995) Geostandards Newsletter v. 19, no. 1, p. 1-23
91500	1063.6 ± 0.40	1065.9 ± 0.6	CA-TIMS	single crystal	Horstwood et al. (2014) Geostandards and Geoanalytical Research, in review
FC-1	1099.5 ± 0.5	1099.0 ± 0.6	ID-TIMS	small crystals	Paces and Miller (1999) Journal of Geophysical Research, v. 98, no. B8, 13997-14013.
FC-1	1095.32 ± 0.33	1098.47 ± 0.16	CA-TIMS	small crystals	Mattinson (2010) Chem. Geol., v. 275, p. 186-198.
Oracle	1436.2 ± 1.3	1437.05 ± 0.77	CA-TIMS	small crystals	S. Bowring (written communication)
Tan Brown	2507.8 ± 1.5	2512.24 ± 0.71	ID-TIMS	Variable size crystals	ID-TIMS analyses in progress by Ann Bauer at MIT....
Tan Brown	2508.9 ± 1.2	2511.95 ± 0.86	CA-TIMS	Variable size crystals	ID-TIMS analyses in progress by Ann Bauer at MIT....
OG-1	3440.7 ± 3.2	3465.4 ± 0.6	ID-TIMS	small crystals	Bodorkos et al. (2009) AGU abstract #V33B-2044
OG-1	3463.3 ± 3.6 Ma	3467.1 ± 0.6 Ma	CA-TIMS	small crystals	Bodorkos et al. (2009) AGU abstract #V33B-2044

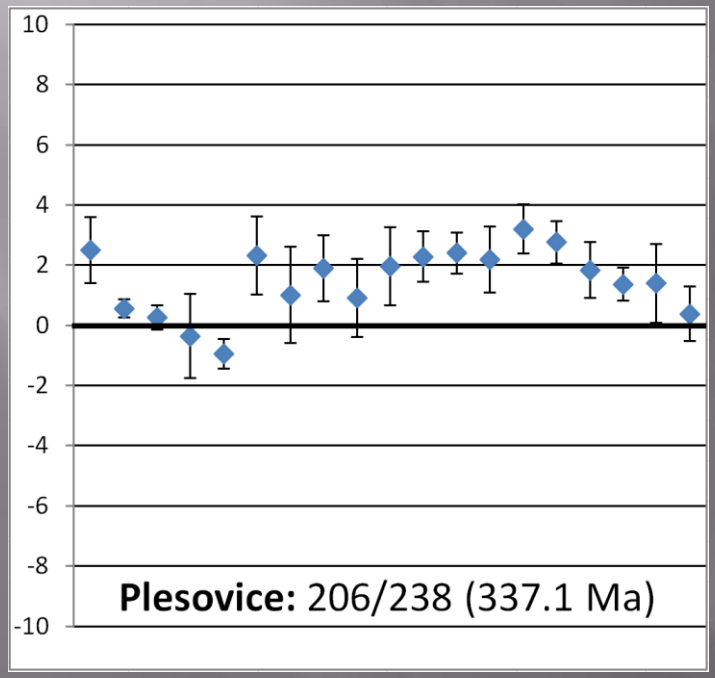


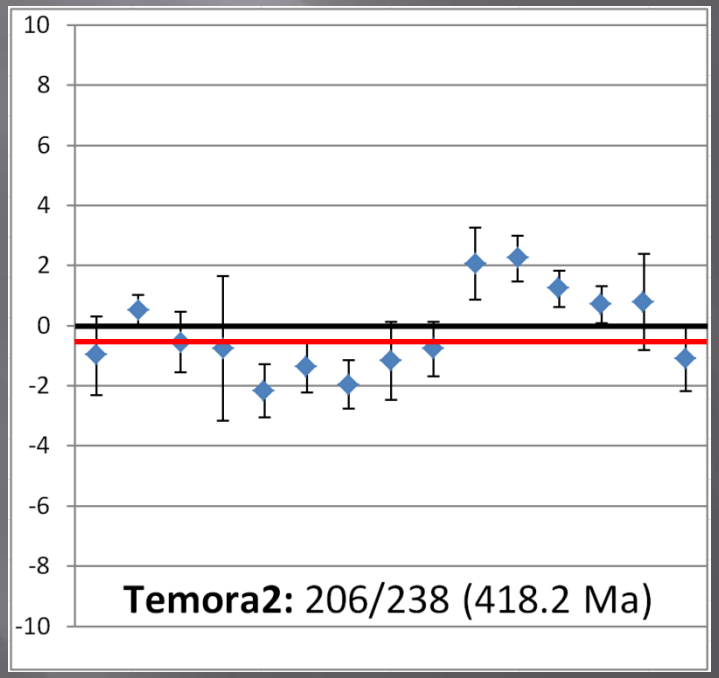


Non-CA

CA

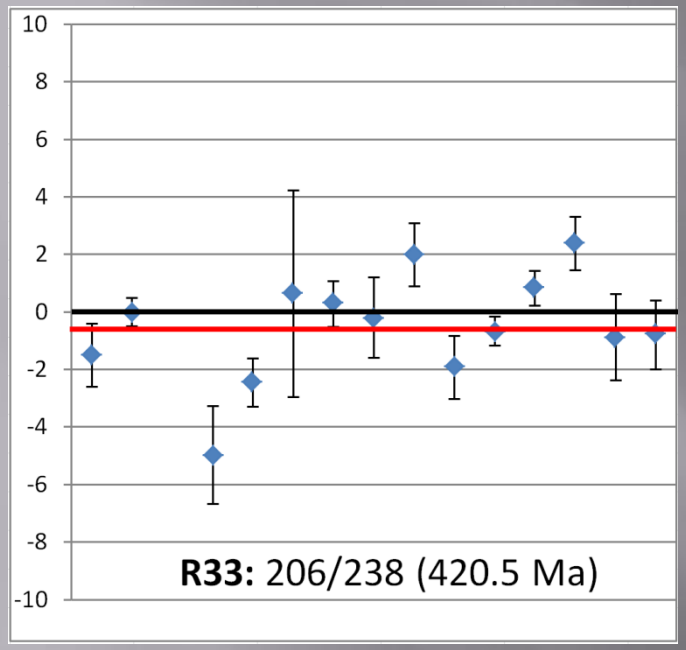
Fish Canyon & 94-35: Challenging!





Plesovice: Consistently 1-2% older than CA!

Temora 2: Better match with non-CA values?

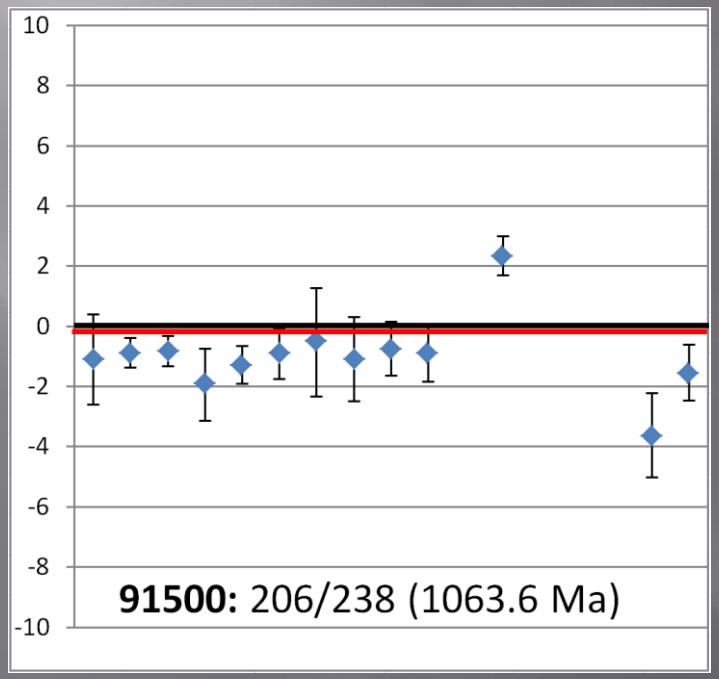


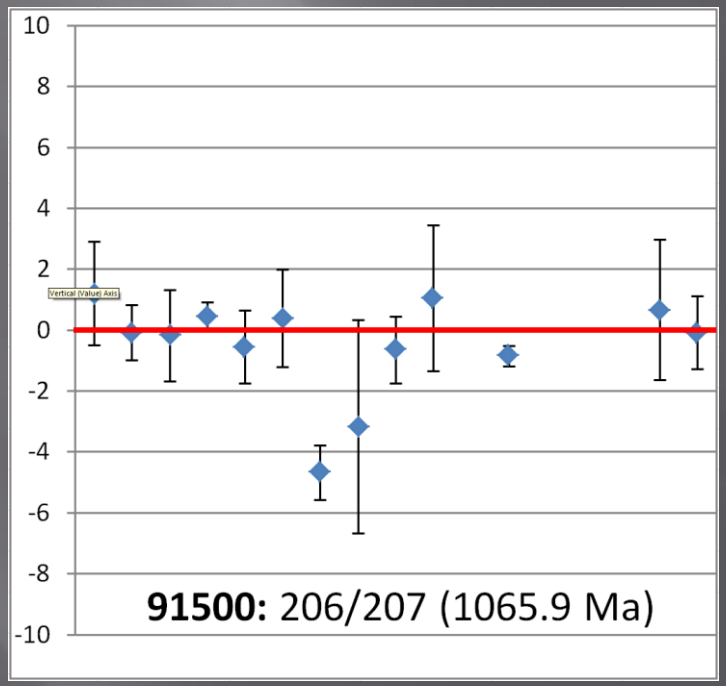
R33:

- Better match with non-CA values?
- Results more scattered than Temora – why?

91500:

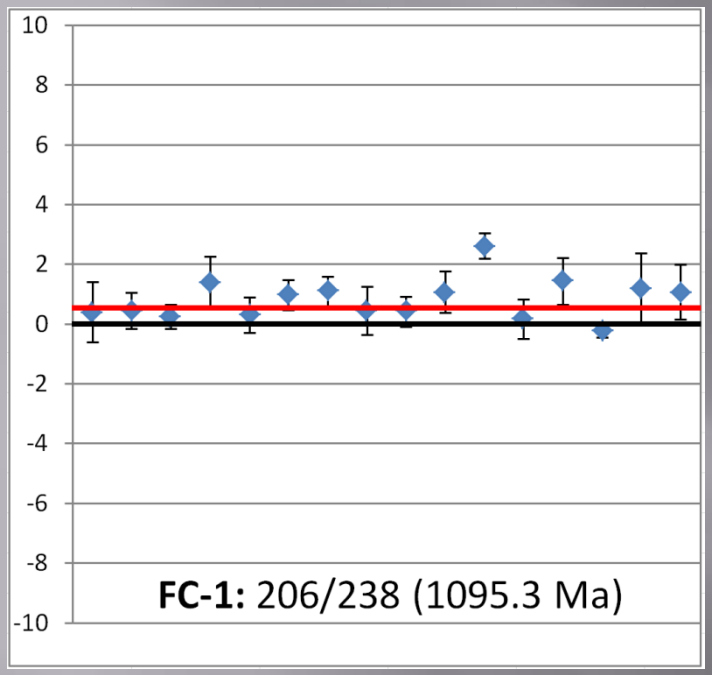
- 206/238 consistently ~1% younger than CA and non-CA values
- 207/206 reasonable match

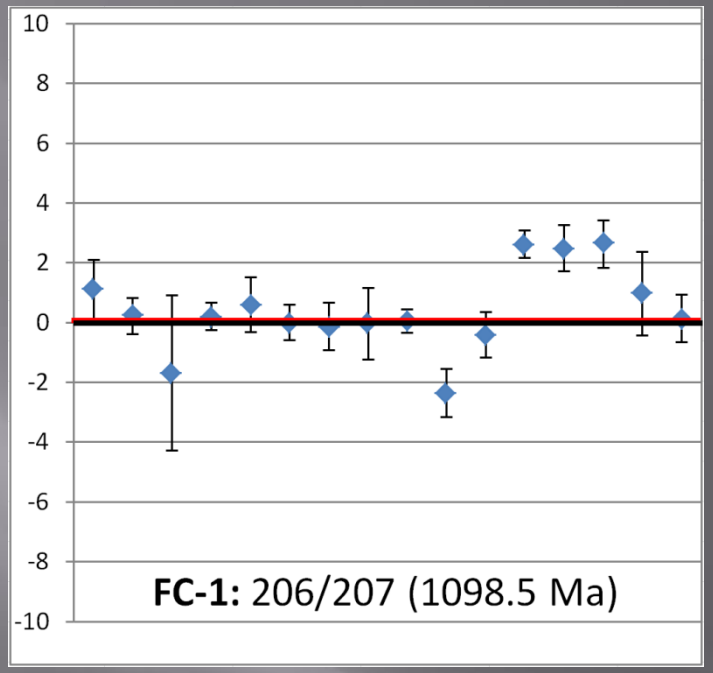




Non-CA

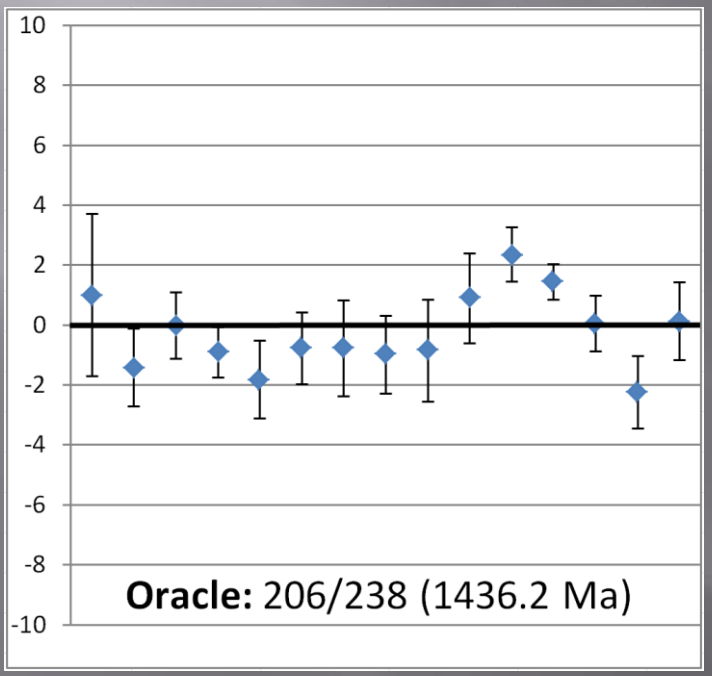
CA

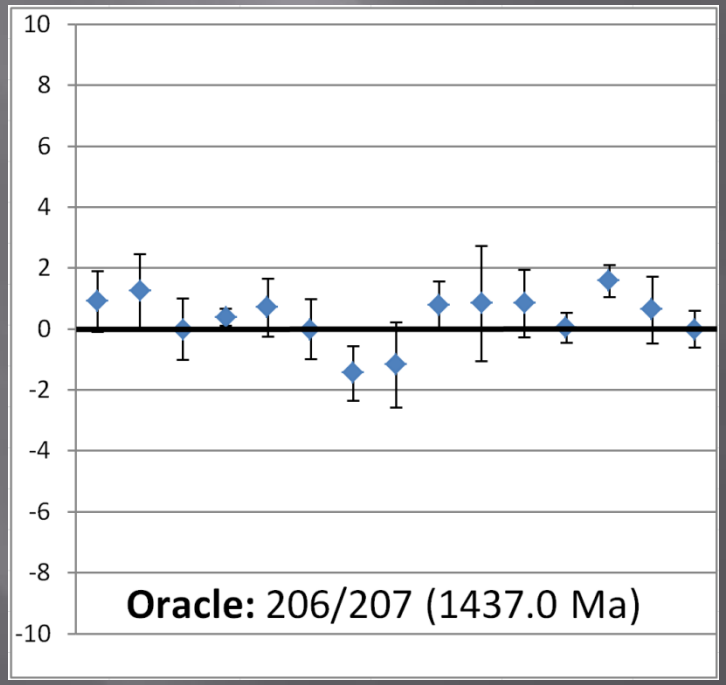




FC-1:

- 206/238 better match with non-CA
- 207/206 OK!



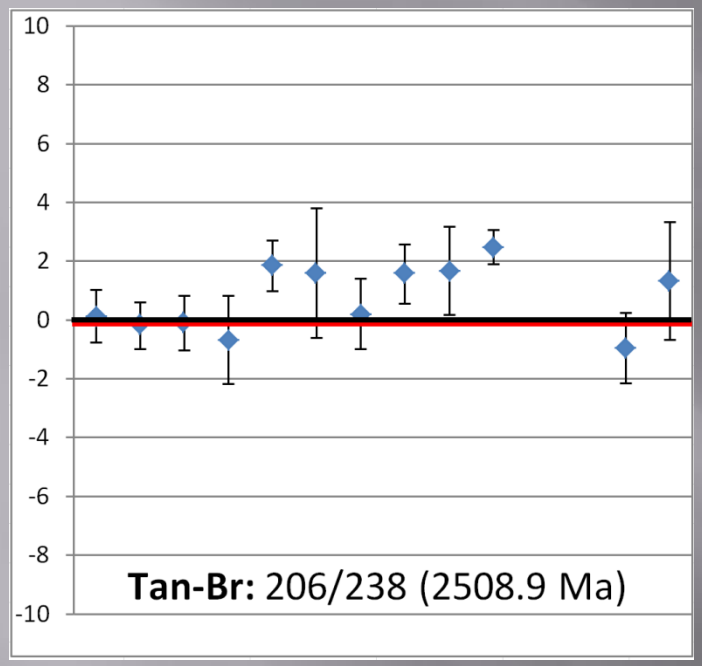


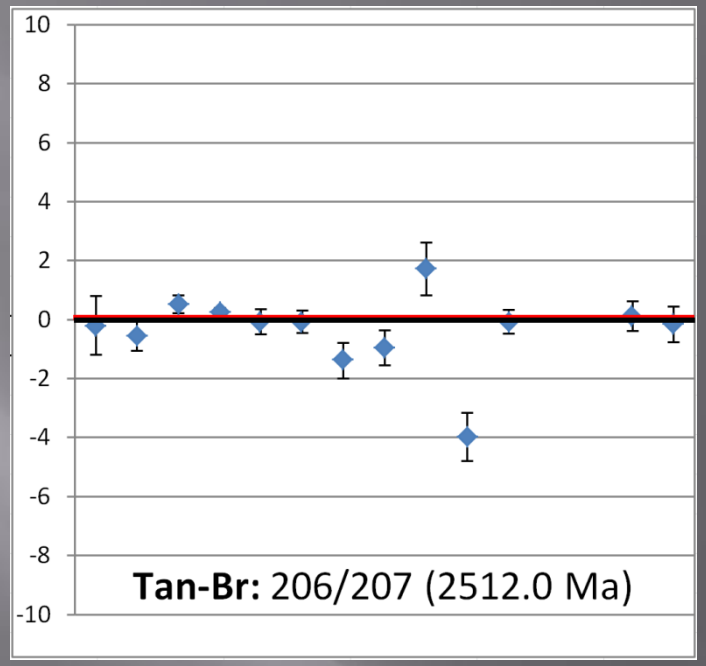
Oracle:

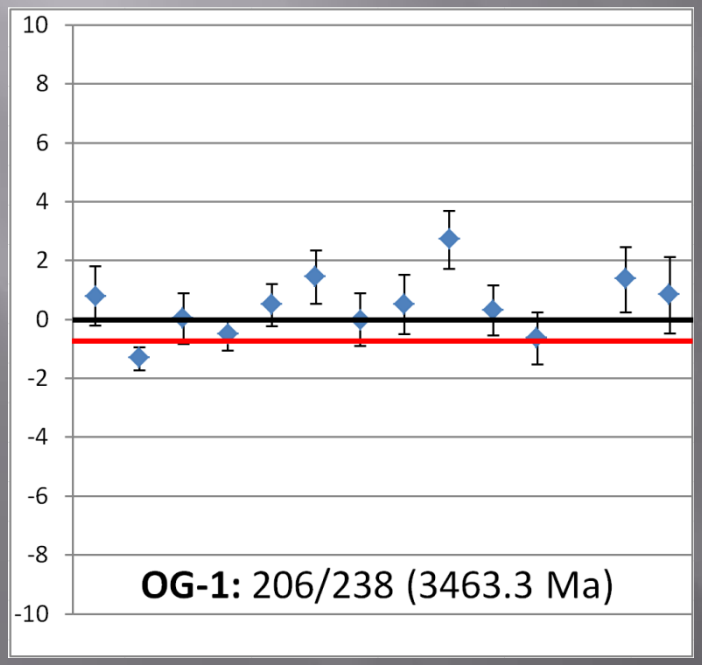
- 206/238 OK!
- 207/206 OK!

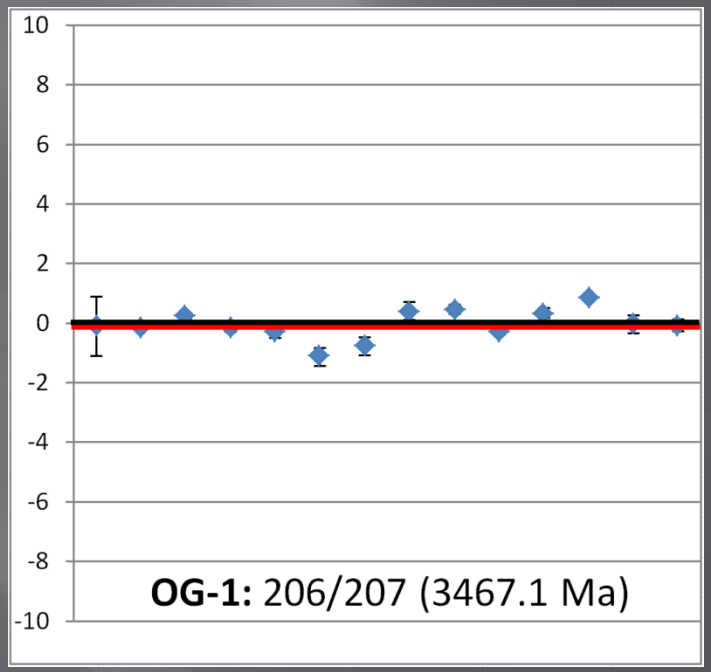
Non-CA

CA









Tan-Br:

- 206/238 a little old?
- 207/206 OK, but needs systematic uncertainty!

OG-1 :

- 206/238 older than both CA and non-CA values (stronger, uncorrected LIEF?)
- 207/206 OK, but needs systematic uncertainty

— Non-CA

— CA

General conclusions

1. 206/238 by (non-CA-)LA-ICPMS better match with non-CA ID-TIMS values
➔ (non-CA-)LA-ICPMS 206/238 should be referenced to non-CA values!
➔ If referenced to CA values, (non-CA-)LA-ICPMS ages generally too young!

2. 207Pb/206Pb results by LA-ICPMS agree with CA & non-CA values

3. Some anomalies:
OG1: 206/238 ages by (non-CA-)LA-ICPMS older than CA & non-CA ages!
FC-1: 206/238 ages by (non-CA-)LA-ICPMS & non-CA are older than CA ages!
91500: (non-CA-)LA-ICPMS 206/238 ages younger than CA & non-CA ages!

4. Accuracy for pooled analyses (e.g., igneous samples):
206/238 – average offset 0.2% +/- **3.6%** 2SD (worse for younger samples)
206/207 – average offset 0.01% +/- **2.4%** 2SD (better for older samples)

5. Accuracy for individual analyses (e.g., detrital samples):
206/238 = +/- **4.5%** 2SD
207/206 = +/- **3%** 2SD

General conclusions

6. Systematic uncertainties need to be reported with data

7. Present data set too small to really document patterns, please send more! (Results will remain anonymous)

8. Bad news: LA-ICPMS & TIMS communities have some work to do!
   Good news: Efforts should help improve accuracy of LA-ICPMS!