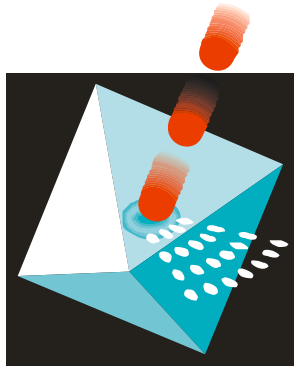
U-Th-Pb Standards…..



Mount Unknowns & Standards Together

Info From Secondary Standards?

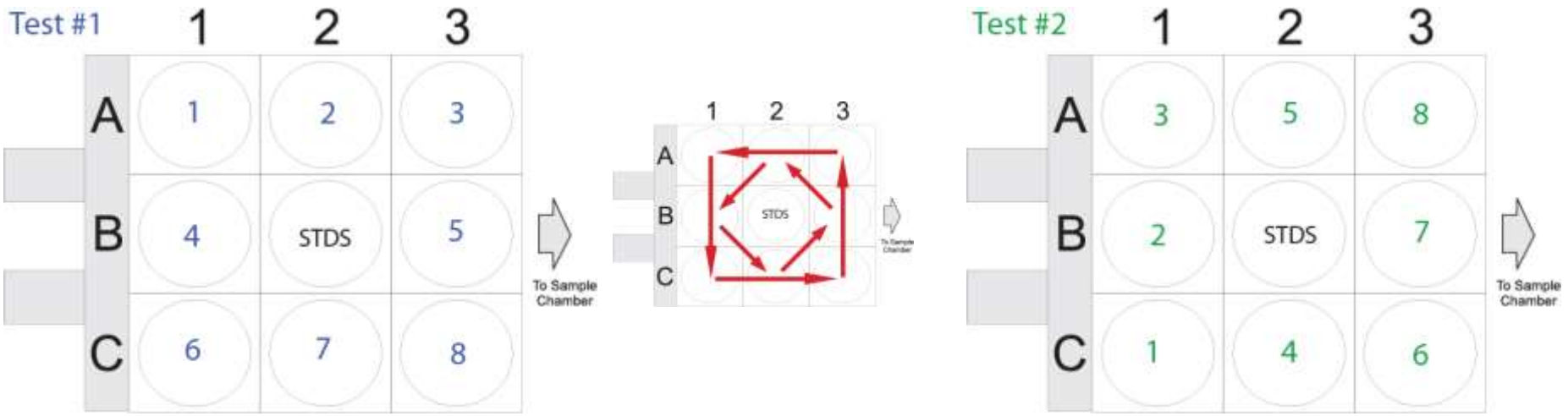
2009 workshop:
Compile info about standards
Distribute to various labs for analysis
Compare results

George Gehrels
Department of Geosciences
University of Arizona
Tucson, AZ 85721

THE UNIVERSITY OF ARIZONA.

ARIZONA LASERCHRON CENTER

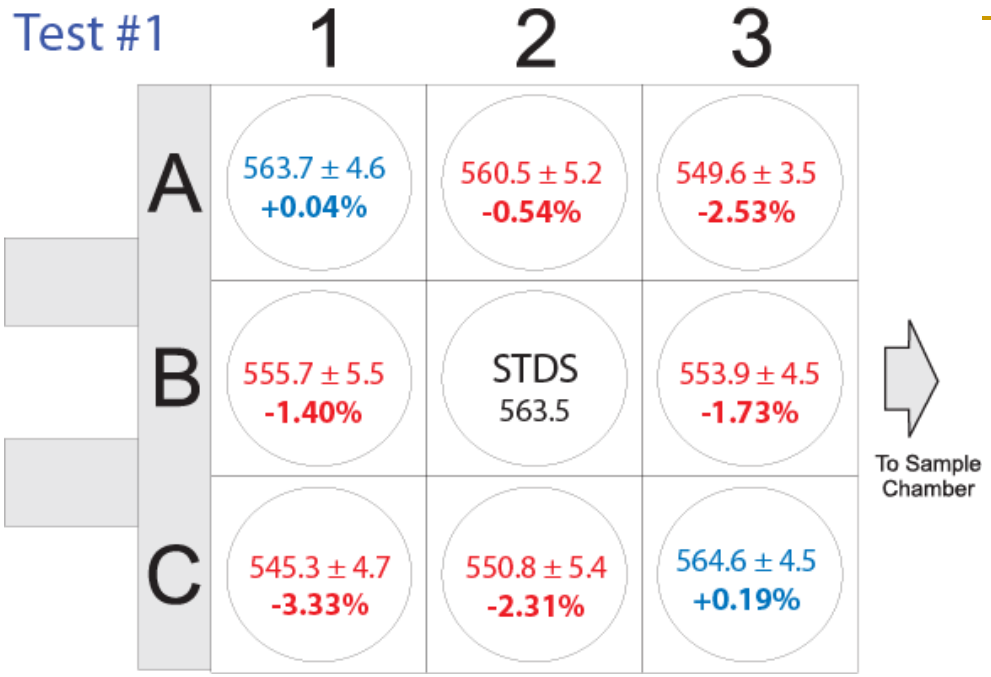
Test of Pb/U fractionation & U sensitivity by position using HeLex 9-hole sample tray



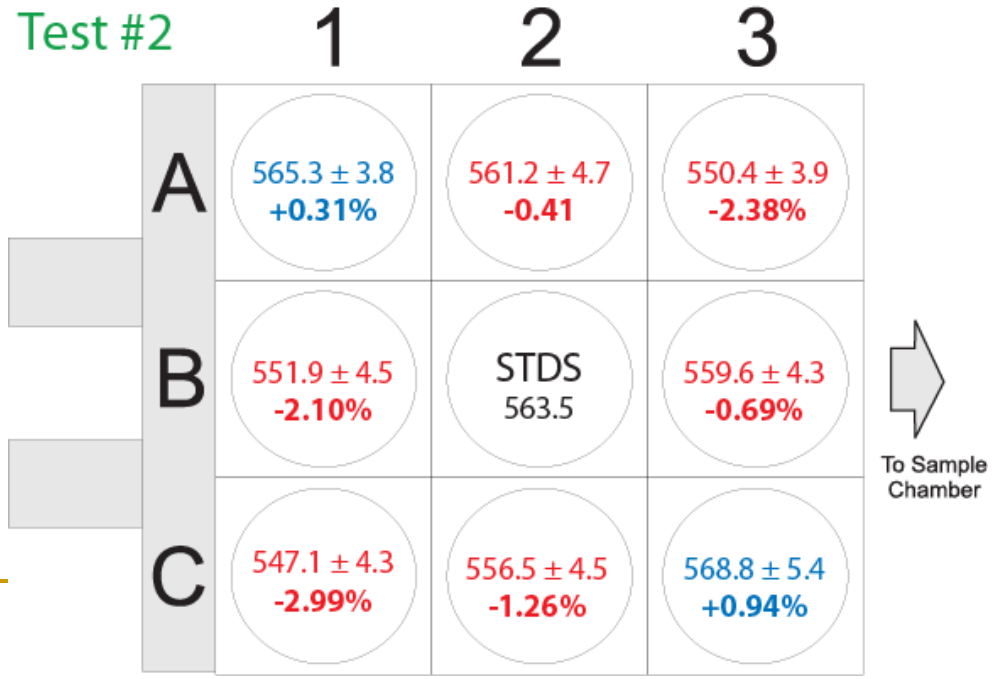
9 mounts made with fragments of a Sri Lanka zircon crystal
(age of 563.5 ± 3.2 Ma and Uconc = 518 ppm)

Center position used as the primary standard , 10x analyses in each position
Mounts then moved to next position as shown and analyses repeated

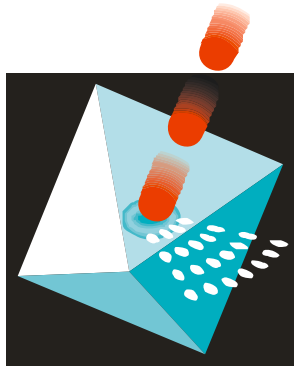
Ages are weighted means with uncertainty at 2-sigma.



➔ Strong correlation between position and U-Pb age!



U-Th-Pb Standards…..



Mount Unknowns & Standards Together

Info From Secondary Standards?

2009 workshop:
Compile info about standards
Distribute to various labs for analysis
Compare results

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Department of Geosciences
University of Arizona
Tucson, AZ 85721

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ARIZONA LASERCHRON CENTER

Info on LaserChron web site

Following are descriptions of various specimens that can be used as standards for geochronology. This information is provided as an ongoing activity of the "Working-Group for Geochronology by LA-ICPMS" -- stay tuned as we incorporate information from other labs and about other materials!

For more information, or if you would like to add information about new samples, please contact George Gehrels (ggehrels@gmail.com).

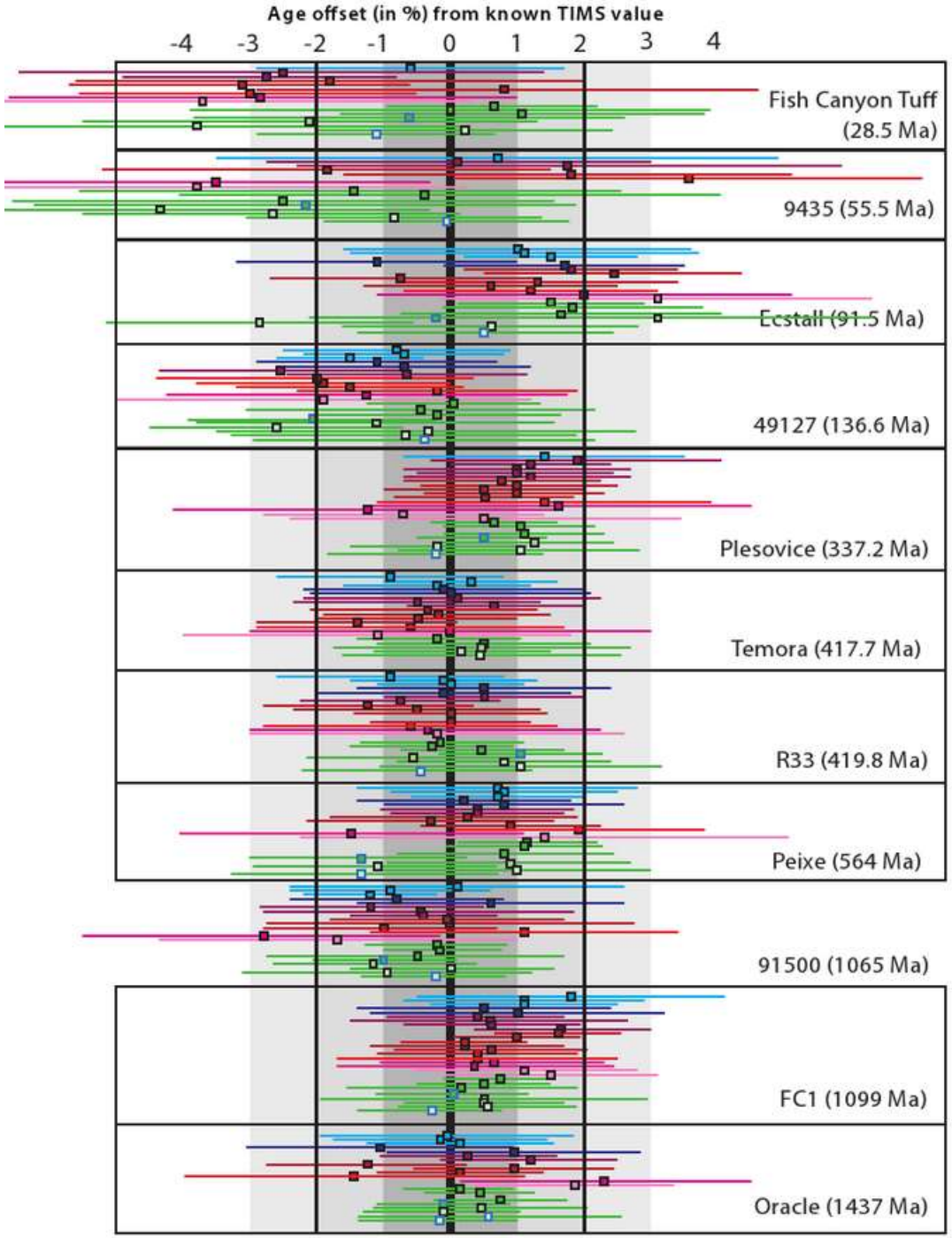
Information provided includes a table with information about each mineral as well as an offset plot showing analyses from the Arizona LaserChron Center.

Zircon Info Table	**Zircon Offset Plot**
Titanite Info Table	**Titanite Offset Plot**
Monazite Info Table	**Monazite Offset Plot**
Apatite Info Table	**Apatite Offset Plot**
Baddeleyite Info Table	**Baddeleyite Offset Plot**
Rutile Info Table	**Rutile Offset Plot**

Following is information about various zircon samples that may be considered for use as geochronologic standards. This information is provided as a component of the Working-Group for Geochronology by LA-ICPMS. For more information, or if you would like to add information about new samples, please contact George Gehrels (ggehrels@gmail.com).

Zircon

Sample	Age (Ma)	Technique (ID-TIMS, CA-TIMS)	Material (single crystal or many smaller crystals)	Publication	Contact Information	Status
Fish Canyon	28.498 ± 0.035	ID-TIMS	Small crystals	Schmitz and Bowring (2001): Geochimica et Cosmochimica Acta, v. 65, no. 15, p. 2571-2587		Uncertain
94-35	55.5 ± 1.5	ID-TIMS	Small crystals	Klepeis et al. (1998): Journal of Structural Geology, v. 20, p. 883-904	George Gehrels (ggehrels@gmail.com)	Available
Ecstall	91.5 ± 1.0 Ma	ID-TIMS	Small crystals	Butler et al. (2002): Journal of Geophysical Research, v. 107, no. B1, 10.1029/2001JB000270.	George Gehrels (ggehrels@gmail.com)	Available
49127	136.6 ± 1 Ma	ID-TIMS	Small crystals	David Kimbrough (unpublished)	David Kimbrough (dkimbrough@geology.sdsu.edu)	Uncertain
Plesovice	337.13 ± 0.37	ID-TIMS	Mid-size crystals	Slama et al. (2008): Chemical Geology, v. 249, p. 1-35.	Jan Kosler (*Jan.Kosler*@geo.uib.no)	Available
Temora-2	417.7 ± 0.4	ID-TIMS	Small crystals	Black et al. (2004): Chemical Geology, v. 205, p. 115-140; and http://earth.boisestate.edu/isotope/analytical-capabilities/id-tims-u-pb/	Keith Sircombe (*keith.sircombe*@ga.gov.au)	Available
R33	419.8 ± 0.4	ID-TIMS	Small crystals	Black et al. (2004): Chemical Geology, v. 205, p. 115-140; and http://earth.boisestate.edu/isotope/analytical-capabilities/id-tims-u-pb/	Bill McClelland (bill-mcclelland@uiowa.edu)	Available
SL2	563.5 ± 3.2	CA-TIMS	Single crystal	Gehrels et al. (2008): Geochemistry, Geophysics, Geosystems, v. 9, Q03017,	George Gehrels (ggehrels@gmail.com)	Not available



Zircon

- 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 $^{206}Pb/^{238}U$ age

-- uncertainties shown at 2-sigma SEM

-- averages calculated from 10 analyses

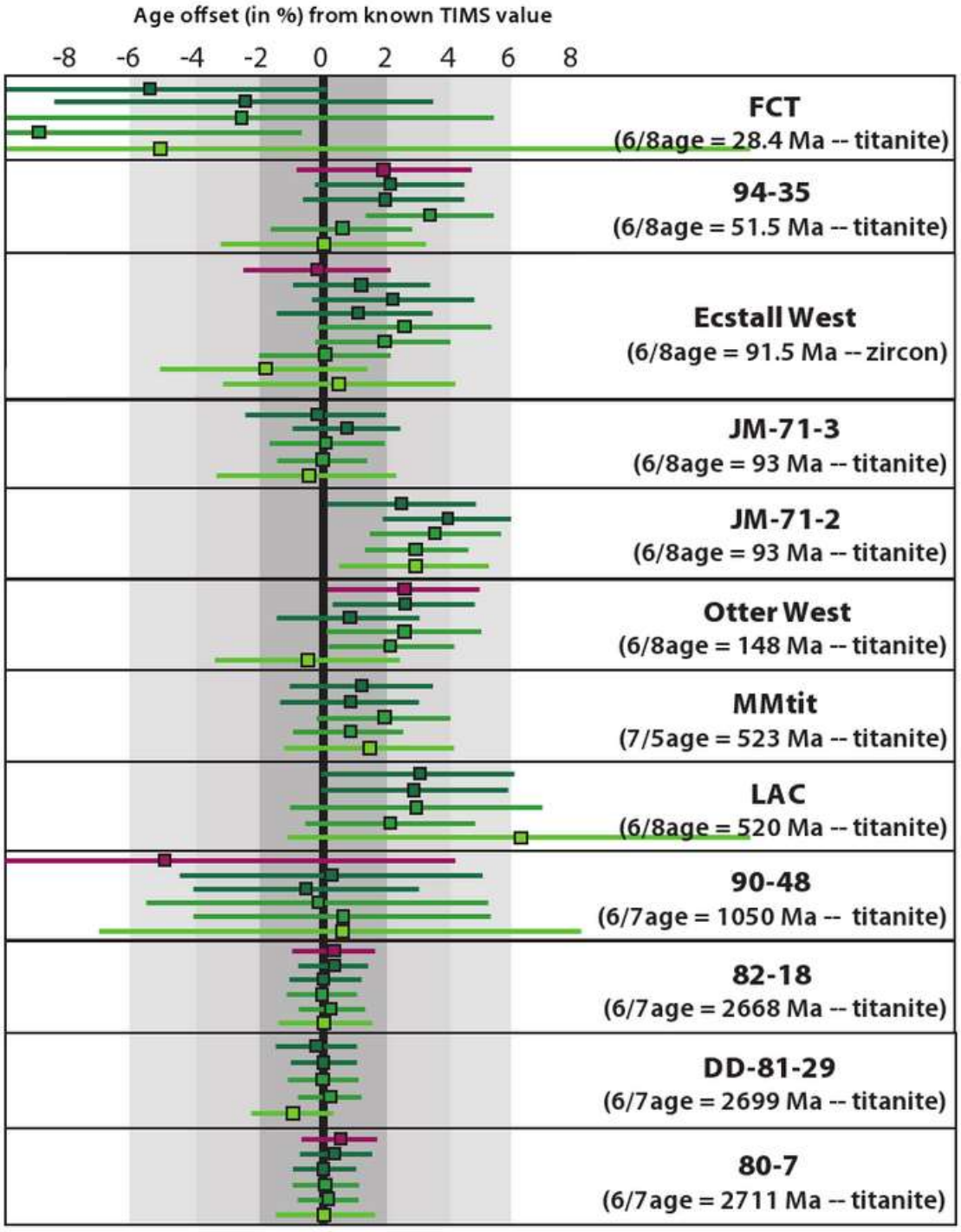
Primary Standard:
Sri Lanka zircon
564 ± 4 Ma (ID-TIMS)
563.5 ± 3.2 Ma (CA-TIMS)

Following is information about various titanite samples that may be considered for use as geochronologic standards. This information is provided as a component of the Working-Group for Geochronology LA-ICPMS. For more information, or if you would like to add information about new samples, please contact Mark Pecha (mpecha@email.arizona.edu).

Titanite

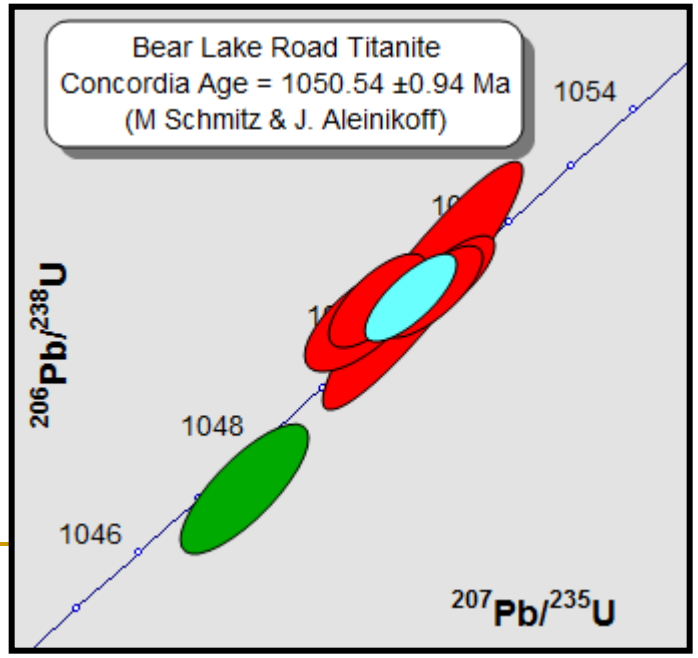
Sample	Age (Ma)	Technique (ID-TIMS, CA-TIMS)	Material (single crystal or many smaller crystals)	Publication	Contact Information	Status
Fish Canyon	28.395 ± 0.049	ID-TIMS	many smaller crystals	Schmitz, M.D. and Bowring, S.A. (2001): Geochimica et Cosmochimica Acta, v. 65, p. 2571-2587		uncertain
94-35	51.5 ± 0.7	ID-TIMS	many smaller crystals	Gehrels (unpublished)	George Gehrels (ggehrels@gmail.com)	available
Ecstall West	91.5 ± 1.0 Ma (zircon)	ID-TIMS (zircon)	many smaller crystals	Butler et al. (2002): Journal of Geophysical Research, v. 107, no. B1, 10.1029/2001JB000270	George Gehrels (ggehrels@gmail.com)	available
JM-71-3	93 ± 1	ID-TIMS	many smaller crystals	Mattinson, J.M. (1978): Contributions to Mineralogy and Petrology, v. 67, p. 233-245		uncertain
JM-71-2	93 ± 1	ID-TIMS	many smaller crystals	Mattinson, J.M. (1978): Contributions to Mineralogy and Petrology, v. 67, p. 233-245		uncertain
Otter West	147.9 ± 1.2	ID-TIMS	many smaller crystals	Butler et al. (2006): Geological Association of Canada, Special Paper 46, p. 171-200	George Gehrels (ggehrels@gmail.com)	available
MMtit	523.3 ± 0.9	ID-TIMS	many smaller crystals	Schoene, B. and Bowring, S.A. (2006): Contributions to Mineralogy and Petrology, v. 151, p. 615-630		uncertain
LAC	520 ± 5	ID-TIMS	multiple crystals (pegmatite)	Pederen et al. (1989): The Caledonide Geology of Scandinavia: p. 3-8.	Jan Kosler (jan.kosler@geo.uib.no)	uncertain
BLS	1049.9 ± 1.3	ID-TIMS	single crystal	Same locality as BLR-1 standard:	George Gehrels	available

Titanite



Nu-NWR: 40 µ beam, far
Nu-PM: 40 µ beam, far
Nu-PM: 30 µ beam, far
Nu-PM: 20 µ beam, far

Notes:
-- BLS (titanite) used as primary standard
-- ages are $^{206}Pb/^{238}U$ unless otherwise indicated
-- uncertainties shown at 2-sigma SEM

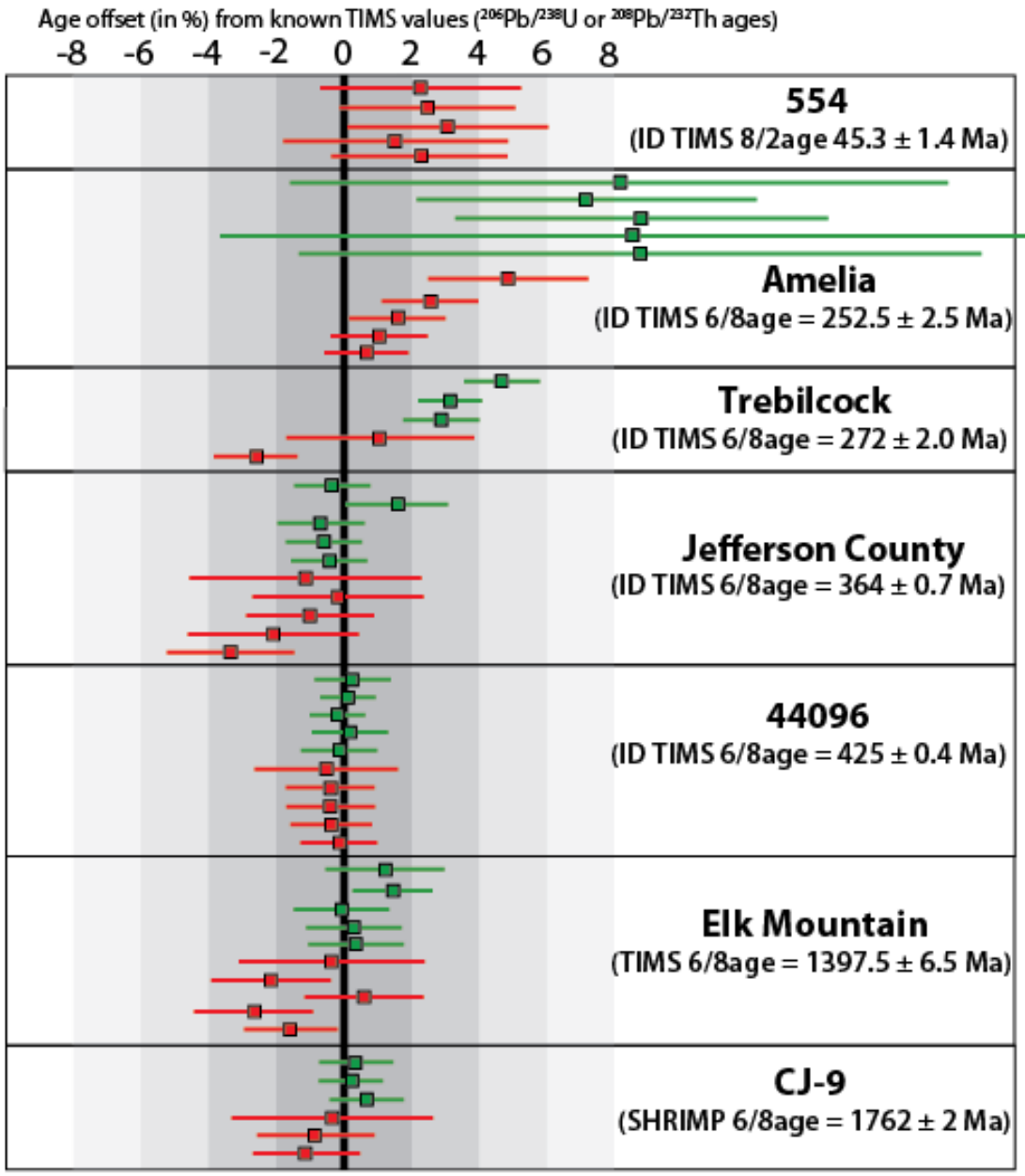


Monazite

Following is information about various monazite samples that may be considered for use as geochronologic standards. This information is provided as a component of the Working-Group for Geochronology by LA-ICPMS. For more information, or if you would like to add information about new samples, please contact Clayton Loehn (cloehn@email.arizona.edu).

Sample	Age (Ma)	Technique (ID-TIMS, CA-TIMS)	Material	Publication	Contact Information	Status
44069	425.8 ± 2.5 Ma	ID-TIMS 6/8 age	small crystals	Aleinikoff et al. (2006): Geological Society of America Bulletin, v. 118, p. 39-64	J. Aleinikoff (jaleinikoff@usgs.gov)	Available
554	46.3 ± 1.2 Ma	ID-TIMS 8/2 age	small crystals	Harrision et al. (1999): Journal of Petrology, v. 40, p. 3-19	G. Gehrels (ggehrels@gmail.com)	Available
Jefferson Co.	363.2 ± 2.4 Ma	ID-TIMS 6/8 age	small crystals	Peterman et al. (2006): Eos, Transactions American Geophysical Union		uncertain
Trebilcock	284.5 ± 2.5 Ma	ID-TIMS 6/8 age	small crystals	Tomascak et al. (1996): Journal of Geology, v. 104, p. 185-195	C. Francis	Uncertain
Elk Mountain	1415 ± 22 Ma	TIMS 6/8 age	small crystals	(Unpublished) J. Baldwin		Uncertain
Amelia	273 ± 27 Ma	ID-TIMS 6/8 age	small crystals	Rutherford Mine – Amelia County, VA Deuser et al. (1962): Journal of Geophysical Research, v. 67, p. 1997-2004	C. Loehn (cloehn@email.arizona.edu)	Available
CJ-9	1769 ± 9.3 Ma	SHRIMP 6/8 age	small crystals	Jones, C.L. (2008): MS Thesis, Kent State University	C. Loehn (cloehn@email.arizona.edu)	Uncertain

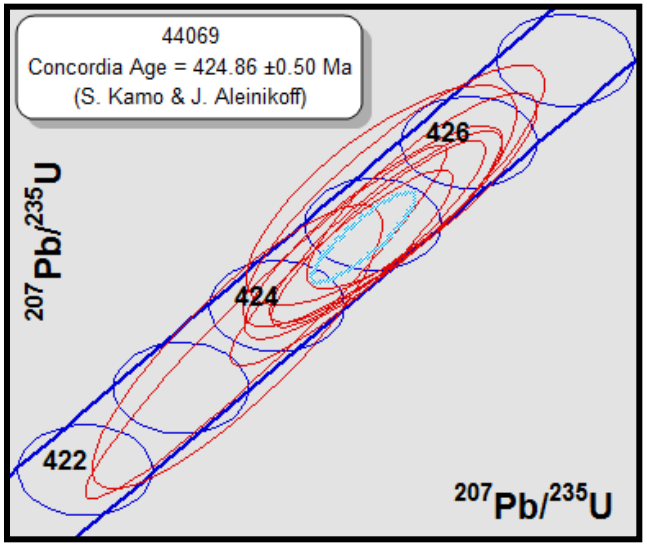
Monazite



Nu-PM: 8 µ beam, far 6/8 age

Nu-PM: 8 µ beam, far 8/2 age

Notes:
-- 44069 (monazite) used as primary standard
-- uncertainties shown at 2-sigma SEM
-- averages calculated from 10 analyses

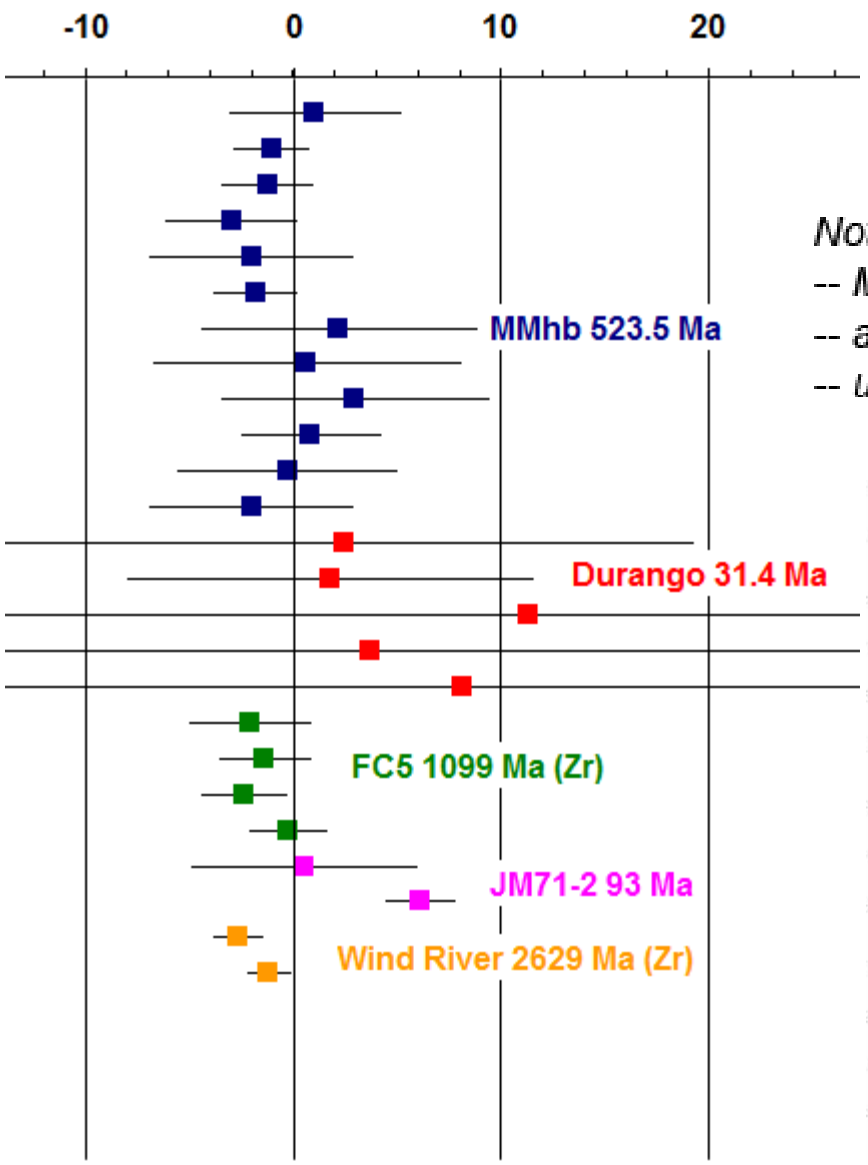


Apatite

Following is information about various apatite samples that may be considered for use as geochronologic reference material. This information is provided as a component of the Working-Group for Geochronology LA-ICPMS. For more information, or if you would like to add information about new samples, please contact Stuart Thomson (thomson@email.arizona.edu).

Sample	Age (Ma)	Technique (ID-TIMS, CA-TIMS)	Material (single crystal or many smaller crystals)	Publication	Contact Information	Status
Madagascar (MAD1)	486.58 ± 0.85	ID-TIMS	Small chips from larger crystal	Thomson et al. (2012): Geochemistry, Geophysics, Geosystems, v. 13, Q0AA21	Stuart Thomson (thomson@email.arizona.edu)	available
McClure Mountain (MMap)	523.5 ± 2.1	ID-TIMS	Mineral Separate	Schoene et al. (2006): Contributions to Mineralogy & Petrology, v. 151, p. 615	Ray Donelick (donelick@apatite.com)	uncertain

Apatite

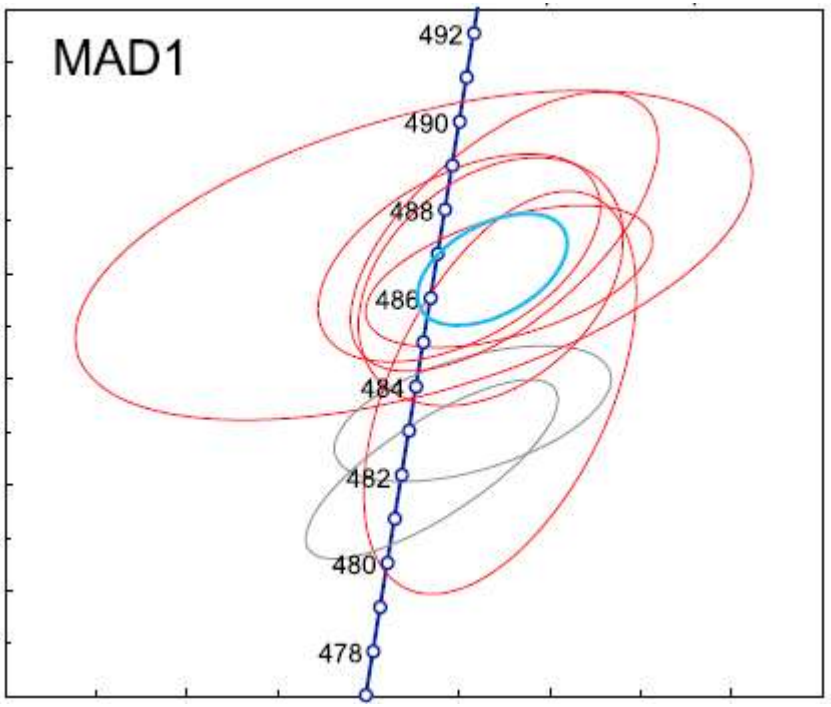


Notes:

-- MAD1 (apatite) used as primary standard

-- ages are $^{206}Pb/^{238}U$ unless otherwise indicated

-- uncertainties shown at 2-sigma SEM

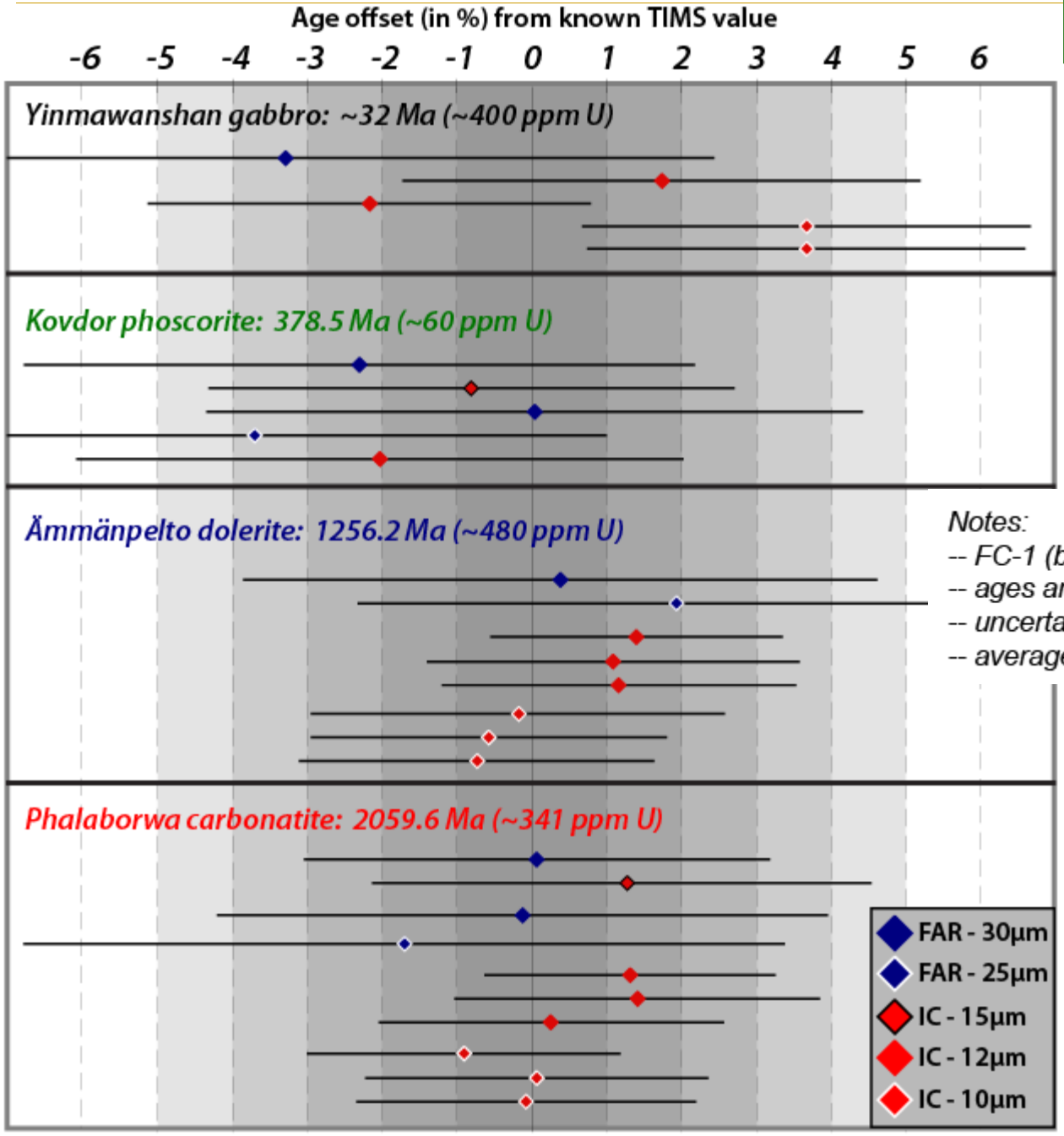


Baddeleyite

Following is information about various baddeleyite samples that may be considered for use as geochronologic and Hf-isotopes standards. This information is provided as a component of the Working-Group for Geochronology by LA-ICPMS. For more information, or if you would like to add information about new samples, please contact Mauricio Ibanez-Mejia (ibanezmejia@gmail.com).

Sample	Age (Ma)	Technique (ID-TIMS, CA-TIMS)	176Hf/177Hf at t=0	Technique (LA-ICPMS, SOL-ICPMS)	Material	Publications	Contact Information	Status
SK10-2	ca. 325	SHRIMP – LA-ICP-MS	0.282738 ±13	SOL-ICP-MS	Small crystals	U-Pb: Li et al. (2010): Journal of Analytical Atomic Spectrometry, v. 25, p. 1107-1113; and Ibanez-Mejia et al. (*in prep*) Hf: Wu et al. (2006): Chemical Geology, v. 234, p. 105-126	Fu-Yuan Wu – Chinese Academy of Sciences (wufuyuan@mail.igcas.ac.cn)	
Kovdor	378.54 ± 0.23	ID-TIMS	0.282767 ±5	SOL-ICP-MS	Mid-size crystals	U-Pb: Amelin, Y. and Zaitsev, A.N. (2002): Geochimica et Cosmochimica Acta, v. 66, p. 2399-2419; and Schmitt et al. (2010): Chemical Geology, v. 269, p. 386-395. Hf: Ibanez-Mejia et al. (*in prep*)		
Ogden (OG1)	410 ± 8	LA-ICP-MS	0.282694 ±7	SOL-ICP-MS	Small crystals	U-Pb: Ibanez-Mejia et al. (*in prep*); Hf: Ibanez-Mejia et al. (*in prep*)	Mauricio Ibanez-Mejia (ibanezmejia@gmail.com)	Available
FC-1	ca. 1098	ID-TIMS	0.282167 ±5	SOL-ICP-MS	Small crystals	U-Pb: James Crowley (unpublished) Hf: Ibanez-Mejia et al. (*in prep*)	John Goodge (jgoodge@d.umn.edu)	Available
FC-4b	1099.89 ±0.29*	ID-TIMS	NA		Small crystals	U-Pb: Schmitt et al. (2010): Chemical Geology, v. 269, p. 386-395. Steven Hoaglund (2010): MSc thesis University of Minnesota	John Goodge (jgoodge@d.umn.edu)	Available
Ämmänpelto (SA-003)	1260 ±11**	ID-TIMS	0.282167 ±5	SOL-ICP-MS	Small crystals	U-Pb: Suominen (1991): Geological Survey of Finland Hf: Ibanez-Mejia et al. (*in prep*)		

Baddeleyite



Notes:

-- FC-1 (baddeleyite) used as primary standard

-- ages are $^{206}Pb/^{238}U$ unless otherwise indicated

-- uncertainties shown at 2-sigma SEM

-- averages calculated from 10 analyses

Great to have info from various labs!

	LAB X	LAB Y	LAB Z
Zircon Info Table	Zircon Offset Plot	Zircon Offset Plot	Zircon Offset Plot
Titanite Info Table	Titanite Offset Plot	Titanite Offset Plot	Titanite Offset Plot
Monazite Info Table	Monazite Offset Plot	Monazite Offset Plot	Monazite Offset Plot
Apatite Info Table	Apatite Offset Plot	Apatite Offset Plot	Apatite Offset Plot
Baddeleyite Info Table	Baddeleyite Offset Plot	Baddeleyite Offset Plot	Baddeleyite Offset Plot

Who should coordinate?

LA-ICPMS WorkingGroup?

EARTHTIME?

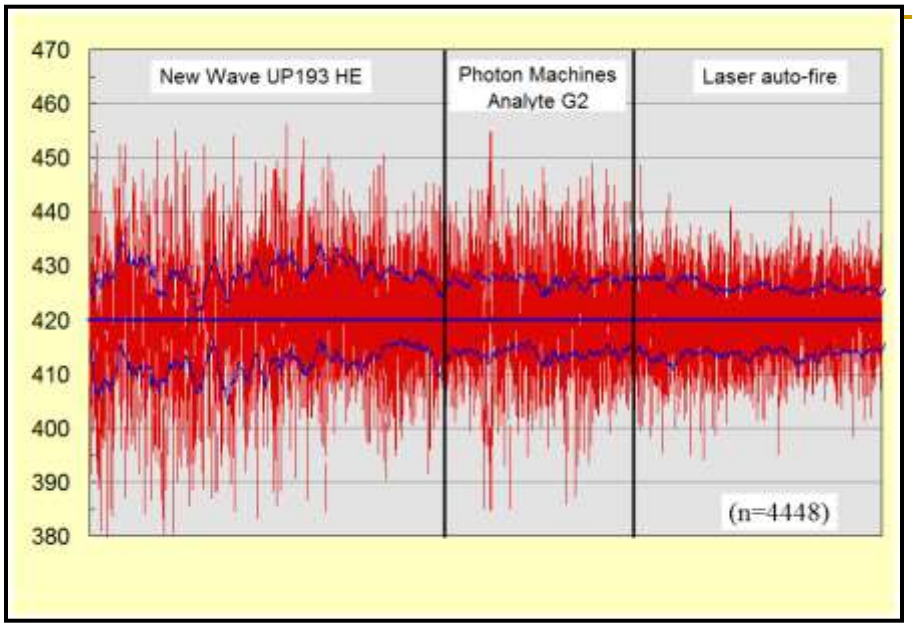
Free-For-All?

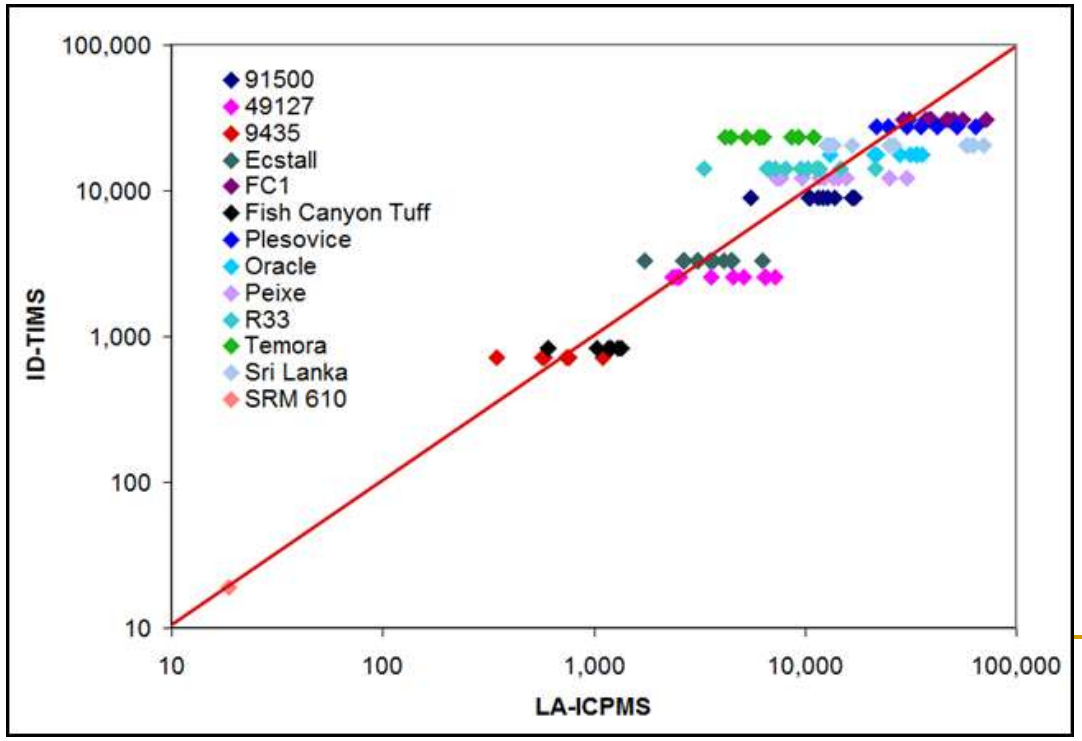
Information Included in Tables

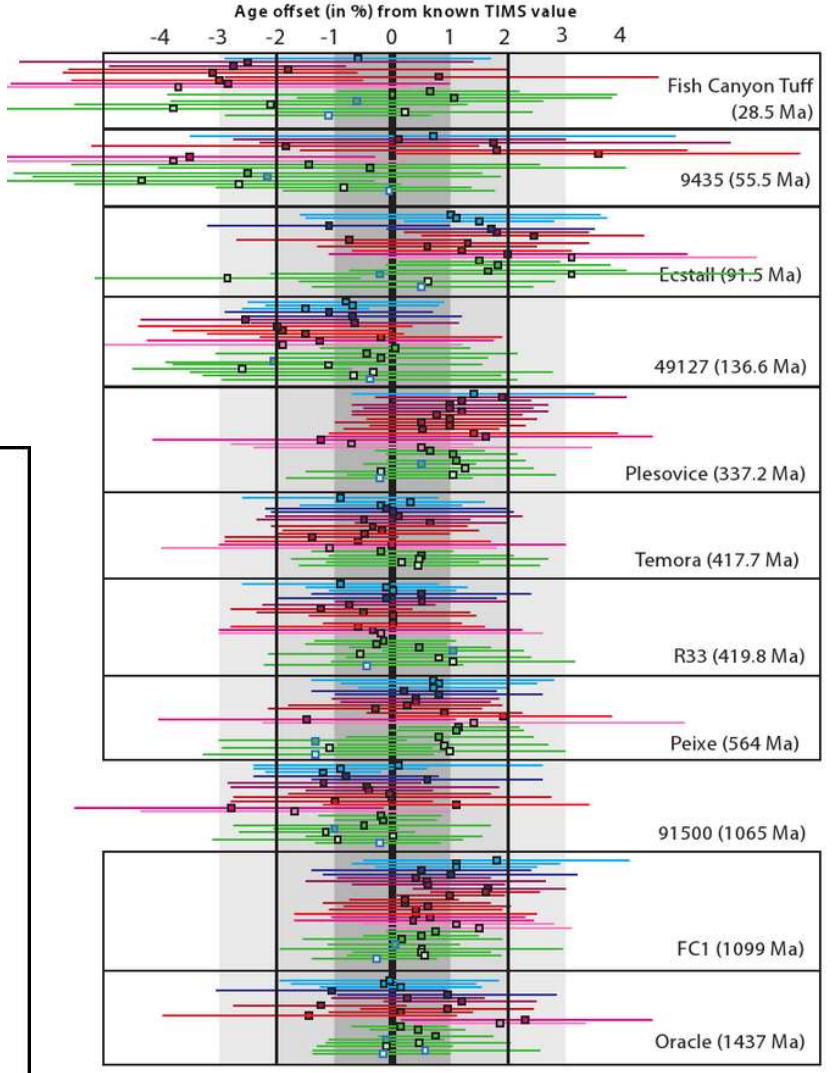
- Name of material
- Age & uncertainty
- Technique (ID-TIMS, CA-TIMS, SIMS)
- Material (fragments of single grain, many smaller grains)
- Citation for age
- Contact for material (who can provide, if available)
- Availability (yes/no)
- _____

➔ Should such a web site present **all** analytical details??

Plots in include?







Best practices for calibration?

ID-TIMS vs CA-TIMS?

R33:	**CA-TIMS**	**ID-TIMS**
	206/238 = 420.53±0.16	206/238 = 419.3±1.0
	207/206 = 422.37±0.36	207/206 = 421.1±3.8
TEMORA-2:	**CA-TIMS**	**ID-TIMS**
	206/238 = 418.37±0.14	206/238 = 416.6±0.9
	207/206 = 420.13±0.30	207/206 = 418.3±5.2

Beware different samples:

FC-1, FC-Z2, AS-3, & AS-57 = all Duluth Gabbro

Sri Lanka, Mud Tank, GJ-1 = different crystals of each