A global compilation of glacial ^{10}Be and ^{26}Al exposure ages

Jakob Heyman

Outline

Data compilation

Production rate and exposure ages

Sample groups and exposure age scatter

Boulder height and exposure ages (does size matter?)

Picking out the good exposure ages

Sample	Latitude (degrees)	Longitude (degrees)	Altitude (m a.s.l.)	Altitude flag	Thickn (cm)	Density (g/cm³)	Shielding	Erosion (cm/yr)	¹⁰Be conc (atoms/g)	¹⁰Be uncert (atoms/g)	10Be standard	26Al conc (atoms/g)	26Al uncert (atoms/g)	26Al standard	Sampling year
SNV-04	37.165	-118.623	3390	std	2.5	2.65	1	0	503050	26466	07KNSTD	0	0	0	2009
SNV-05	37.165	-118.623	3390	std	2.5	2.65	1	0	496861	25387	07KNSTD	0	0	0	2009
SNV-06	37.165	-118.623	3390	std	2.5	2.65	1	0	494459	23961	07KNSTD	0	0	0	2009
SNV-07	37.165	-118.623	3390	std	2.5	2.65	1	0	517655	17311	07KNSTD	0	0	0	2009
SNV-08	37.165	-118.623	3390	std	2.5	2.65	1	0	547250	17135	07KNSTD	0	0	0	2009
MAR-10-02	51.11366	-121.81593	2184	std	3	2.7	0.9981994	0	341993	11318	07KNSTD	0	0	0	2010
MAR-10-04	51.11089	-121.814	2161	std	4	2.7	0.9997741	0	493050	27014	07KNSTD	0	0	0	2010
MAR-10-05	51.11526	-121.81900	2230	std	3	2.7	0.9998586	0	539734	19172	07KNSTD	0	0	0	2010
MAR-10-07	51.12329	-121.84145	2126	std	3	2.7	0.9960744	0	357064	11424	07KNSTD	0	0	0	2010
MAR-10-08	54.3676	-127.04717	1785	std	3	2.7	0.9997661	0	194113	11965	07KNSTD	0	0	0	2010
MAR-10-11	54.36813	-127.03533	1679	std	3	2.7	0.999644	0	176311	6967	07KNSTD	0	0	0	2010
MAR-10-12	54.36869	-127.0335	1661	std	3	2.7	0.9996349	0	190625	17536	07KNSTD	0	0	0	2010
MAR-10-13	54.3663	-127.02705	1608	std	5	2.7	0.9996521	0	160627	6054	07KNSTD	0	0	0	2010
LAB-97-24A	59.32000	-64.84683	730	std	2.5	2.65	1	0	0	0	0	789000	71188	KNSTD	1997
LAB-00-17A	58.63973	-63.59688	713	std	2	2.65	1	0	256069	10243	LLNL3000	1407452	54133	KNSTD	2000
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KAU-99-02A	57.87167	-62.06000	650	std	2.5	2.65	0.9965	0	141000	7257	LLNL3000	0	0	0	1999
MTH-99-01	58.92167	-61.46167	908	std	2.5	2.65	1	0	133000	6488	LLNL3000	0	0	0	1999
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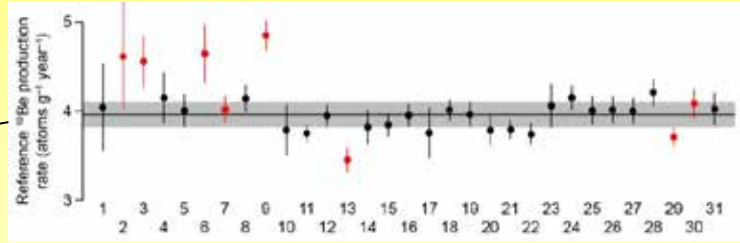
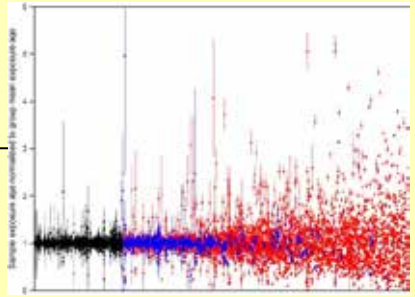
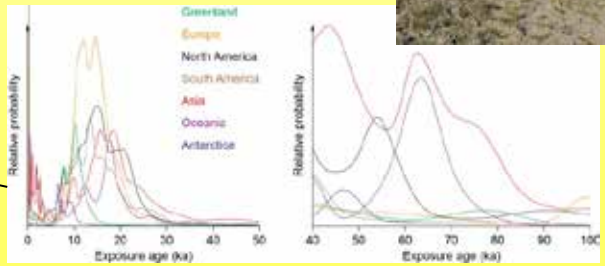
LAB-99-23-1A	59.31333	-64.65000	766	std	2.5	2.65	0.9887	0	106000	10115	LLNL3000	0	0	0	1999
KM95-6	66.183722	-65.563583	661	std	6	2.65	0.99564	0	333000	11000	LLNL3000	2077000	129000	KNSTD	1995
KM95-22	66.266056	-65.799889	393	std	3	2.65	1	0	81000	10000	LLNL3000	452000	36000	KNSTD	1995
KM95-23	66.187167	-65.795528	444	std	3	2.65	1	0	110000	24000	LLNL3000	573000	48000	KNSTD	1995







Sample data

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MAR-10-08	54.3876	-127.04717	1785	std	3	2.7	0.9997661	0	194113	11985	07KNSTD	0	0	0	2010
MAR-10-11	54.38813	-127.03533	1675	std	3	2.7	0.999644	0	176311	8567	07KNSTD	0	0	0	2010
MAR-10-12	54.38869	-127.0335	1661	std	3	2.7	0.9996349	0	198625	17538	07KNSTD	0	0	0	2010
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KM95-23	66.187167	-65.709528	444	std	3	2.65	1	0	110000	24000	LLNL3000	573000	48000	KNSTD	1995

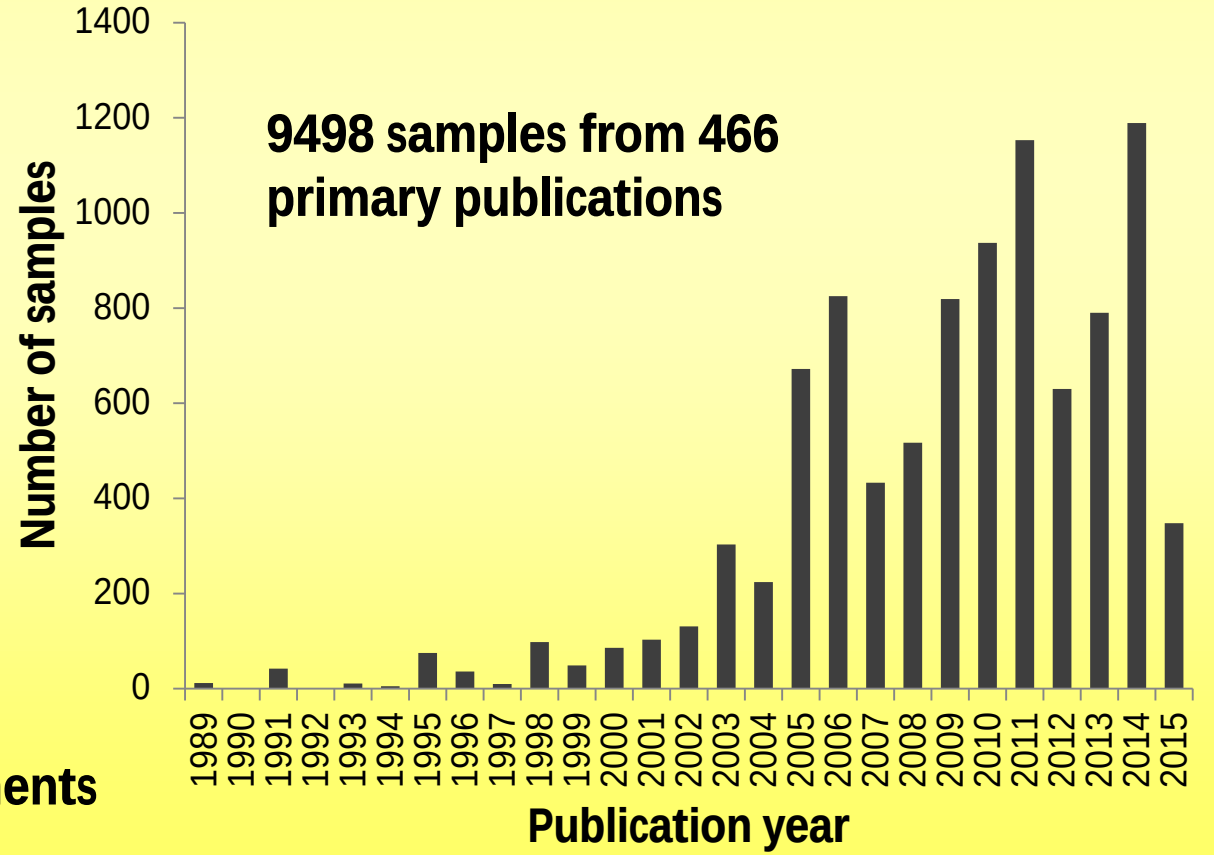
9454 ^{10}Be samples

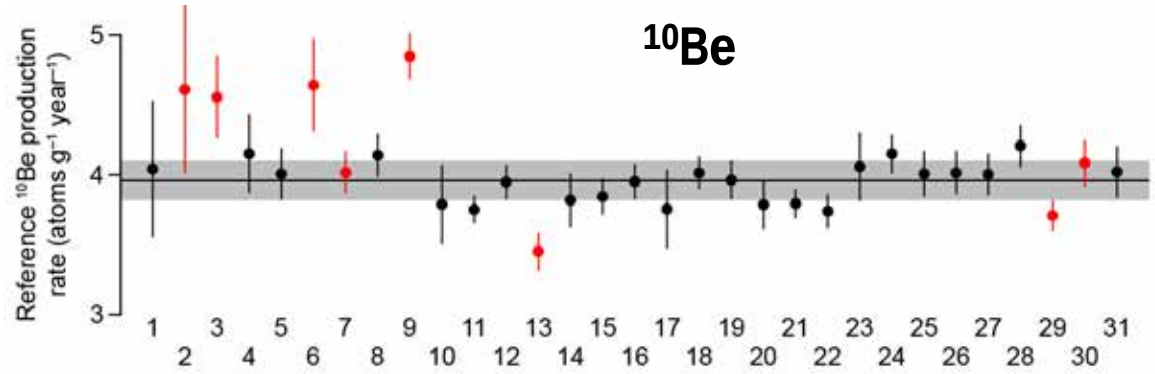
1391 ^{26}Al samples

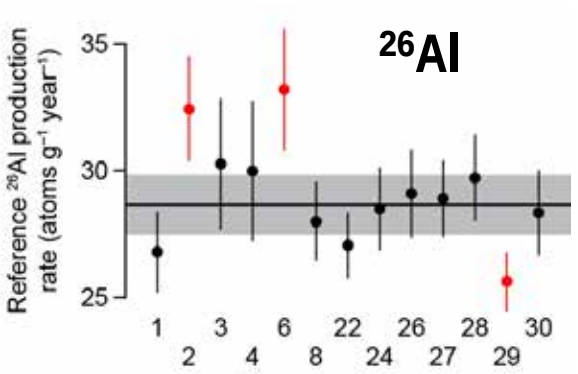
7305 boulders

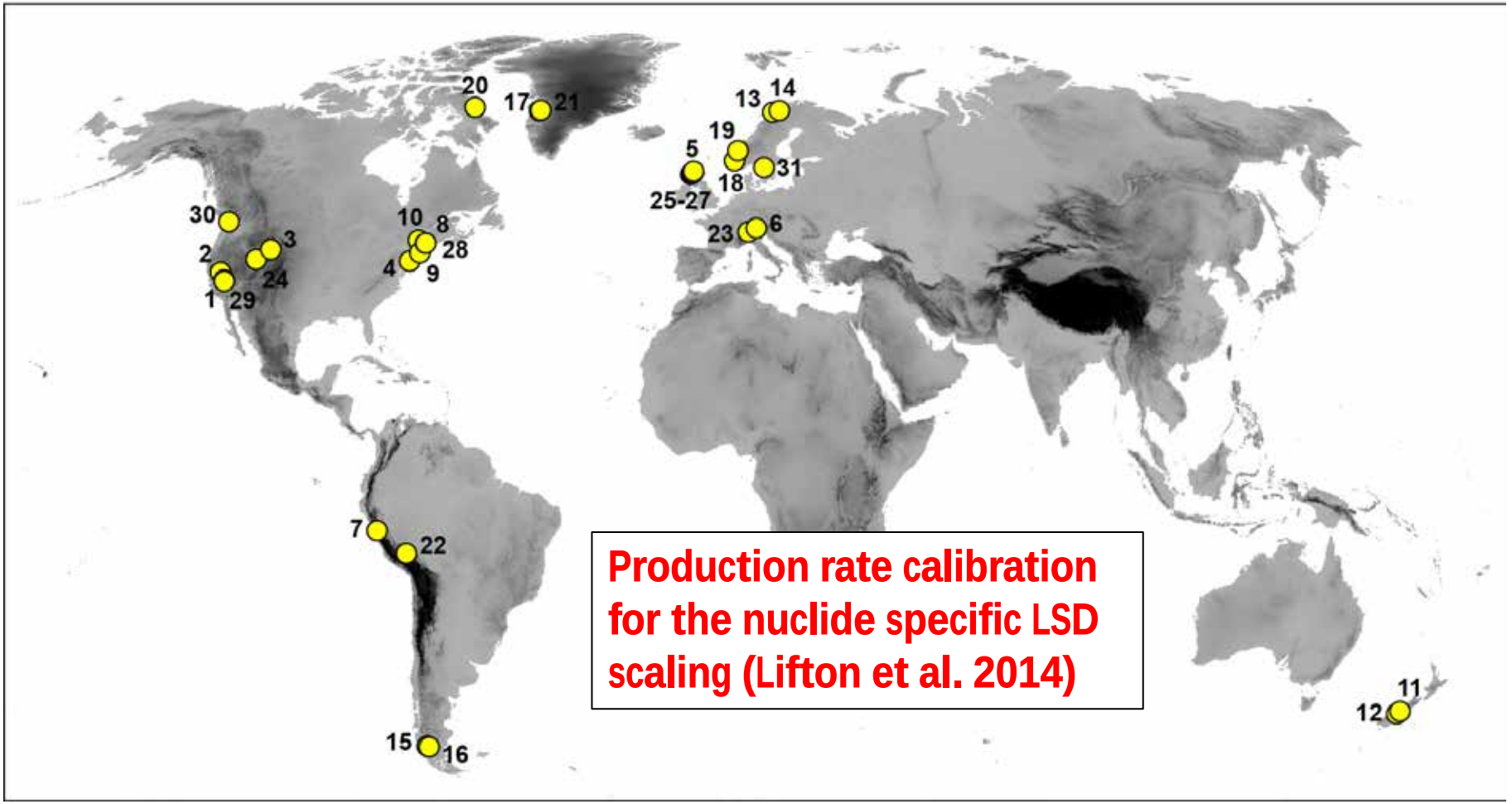
1508 bedrocks

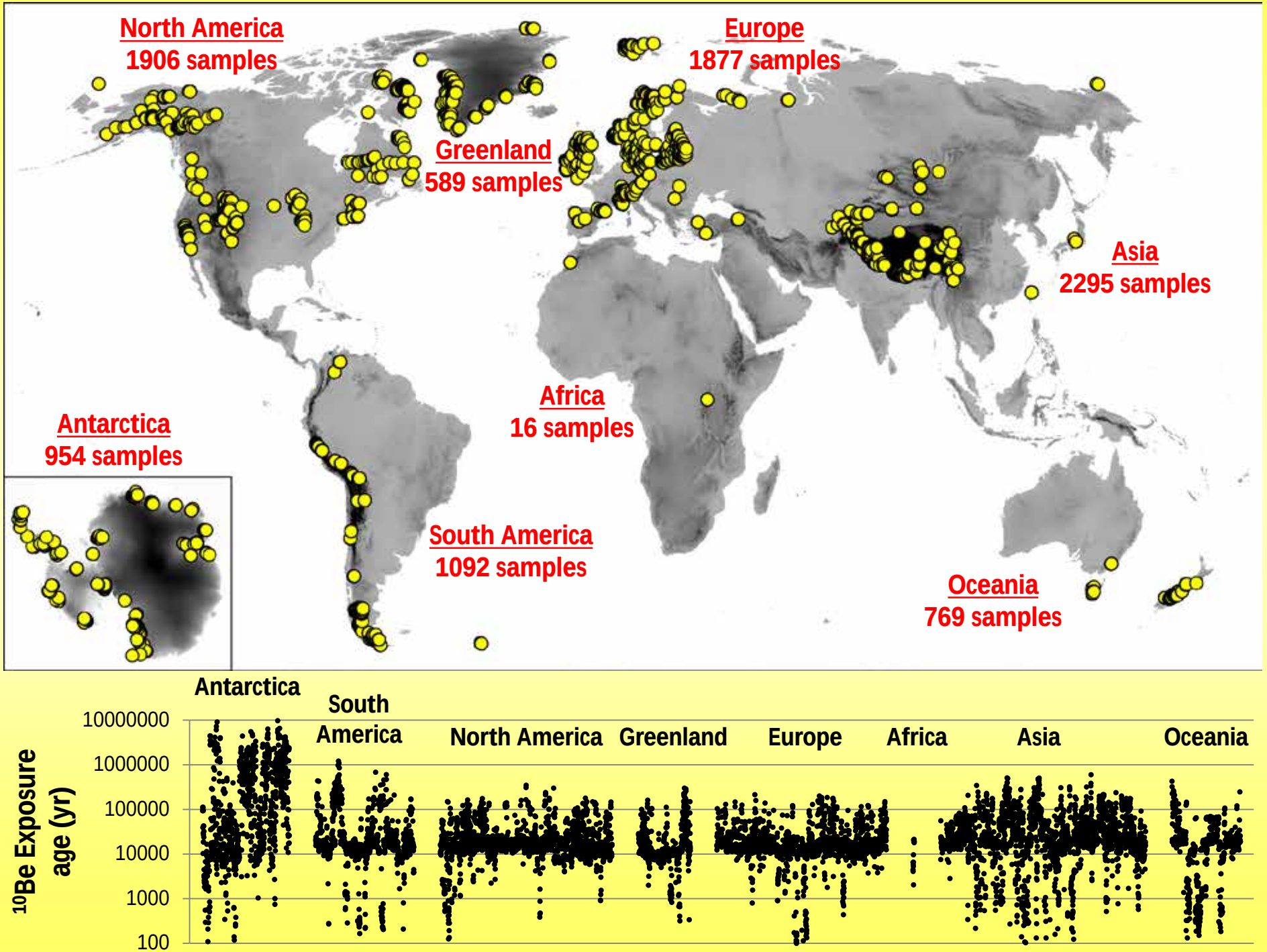
685 cobbles/pebbles/sediments



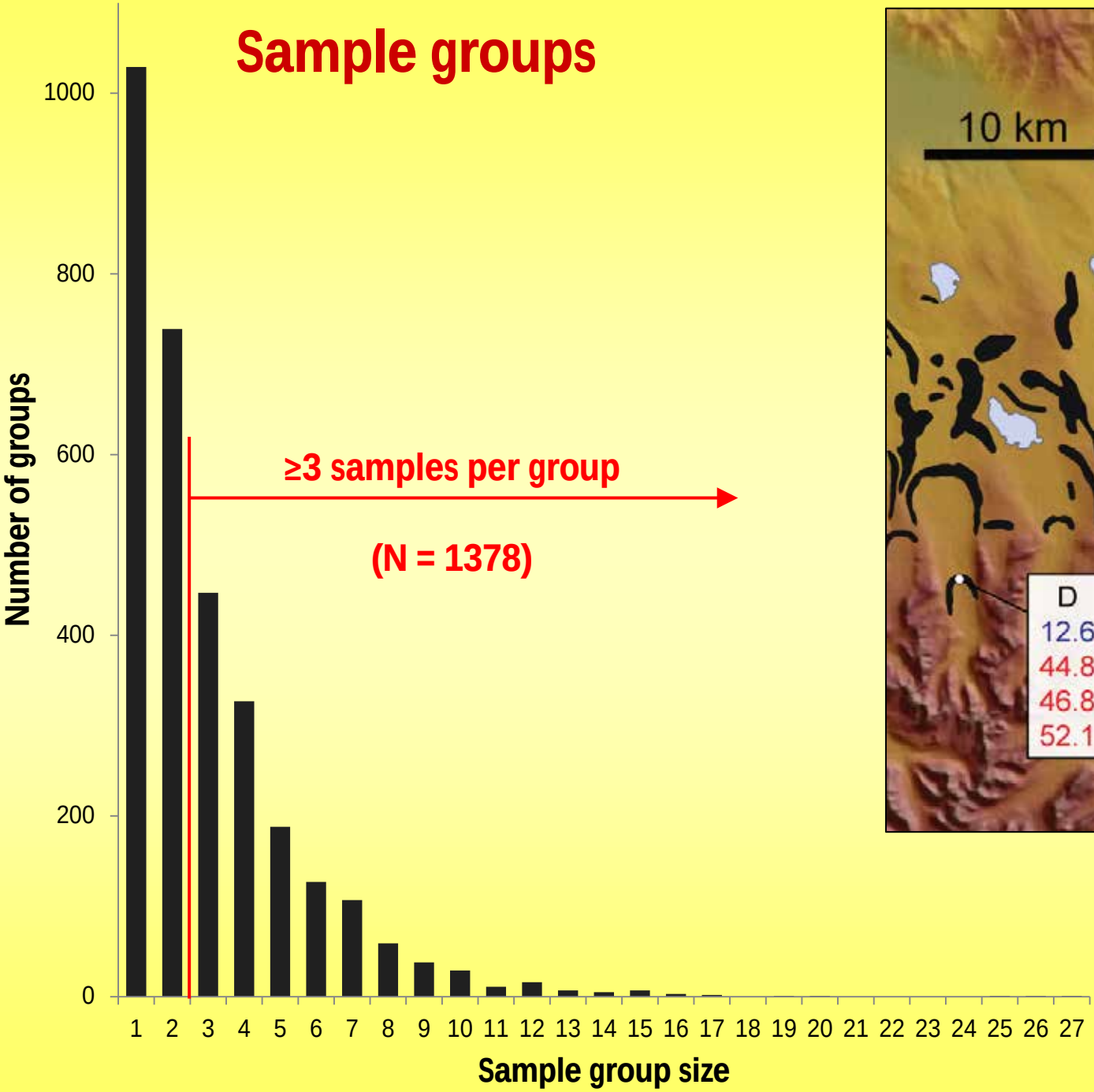

^{10}Be
Reference ^{10}Be production rate (atoms g^{-1} year^{-1})
5
4
3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

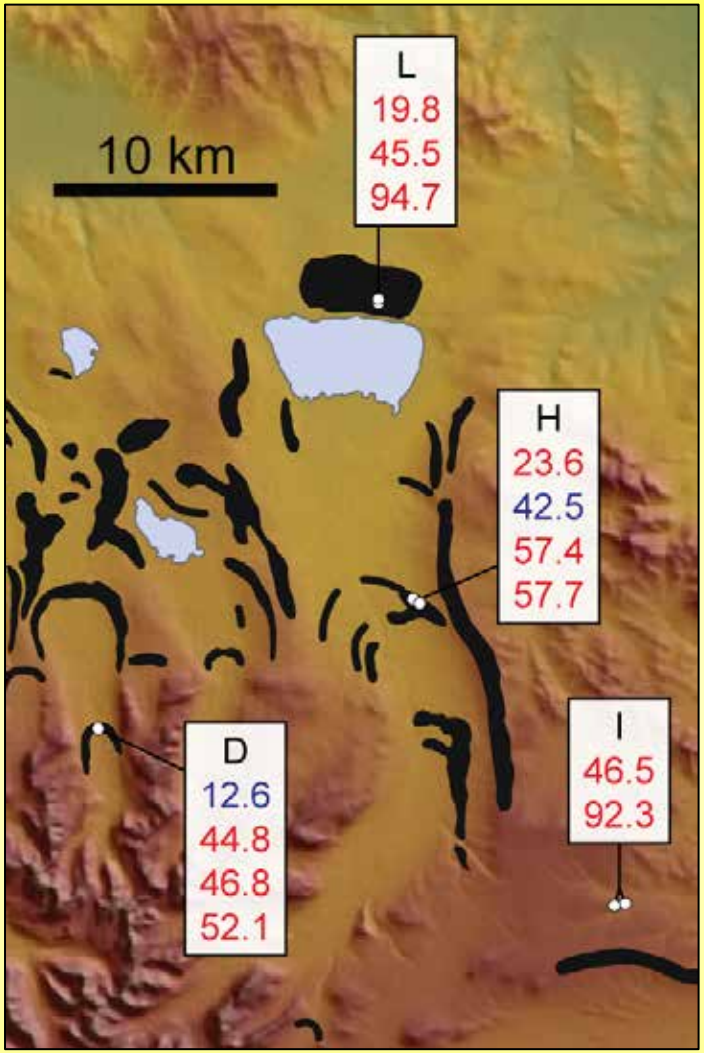

^{26}Al
Reference ^{26}Al production rate (atoms g^{-1} year^{-1})
35
30
25
1 2 3 4 6 8 22 24 26 27 28 29 30


20
17
21
13
14
19
5
18
31
25-27
23
6
30
2
1
29
3
24
10
8
28
4
9
7
22
15
16
11
12
Production rate calibration for the nuclide specific LSD scaling (Lifton et al. 2014)


North America
1906 samples
Europe
1877 samples
Greenland
589 samples
Asia
2295 samples
Africa
16 samples
Antarctica
954 samples
South America
1092 samples
Oceania
769 samples
Antarctica
South America
North America
Greenland
Europe
Africa
Asia
Oceania
10000000
1000000
100000
10000
1000
100
10Be Exposure age (yr)

Sample groups



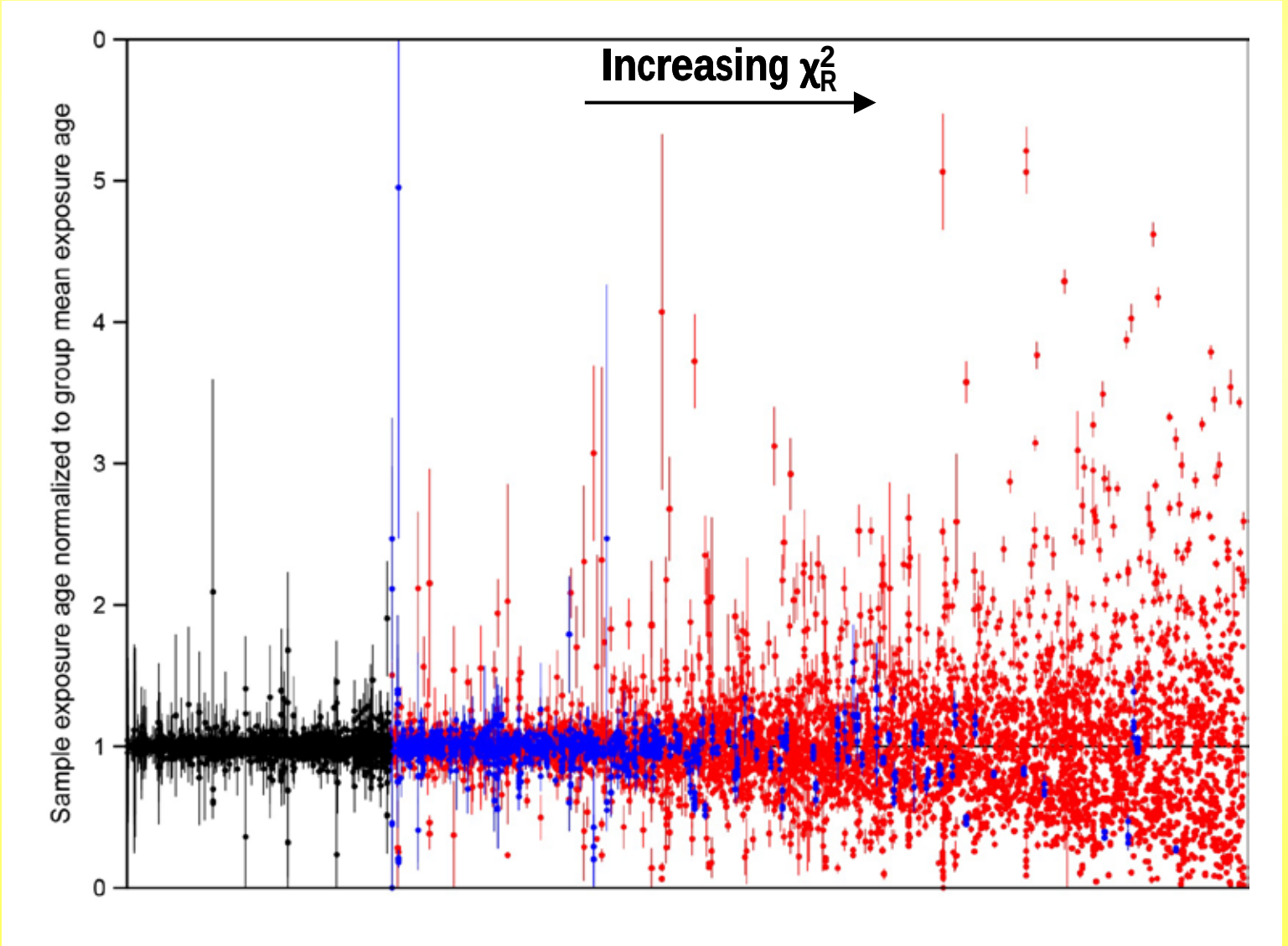


Scatter!

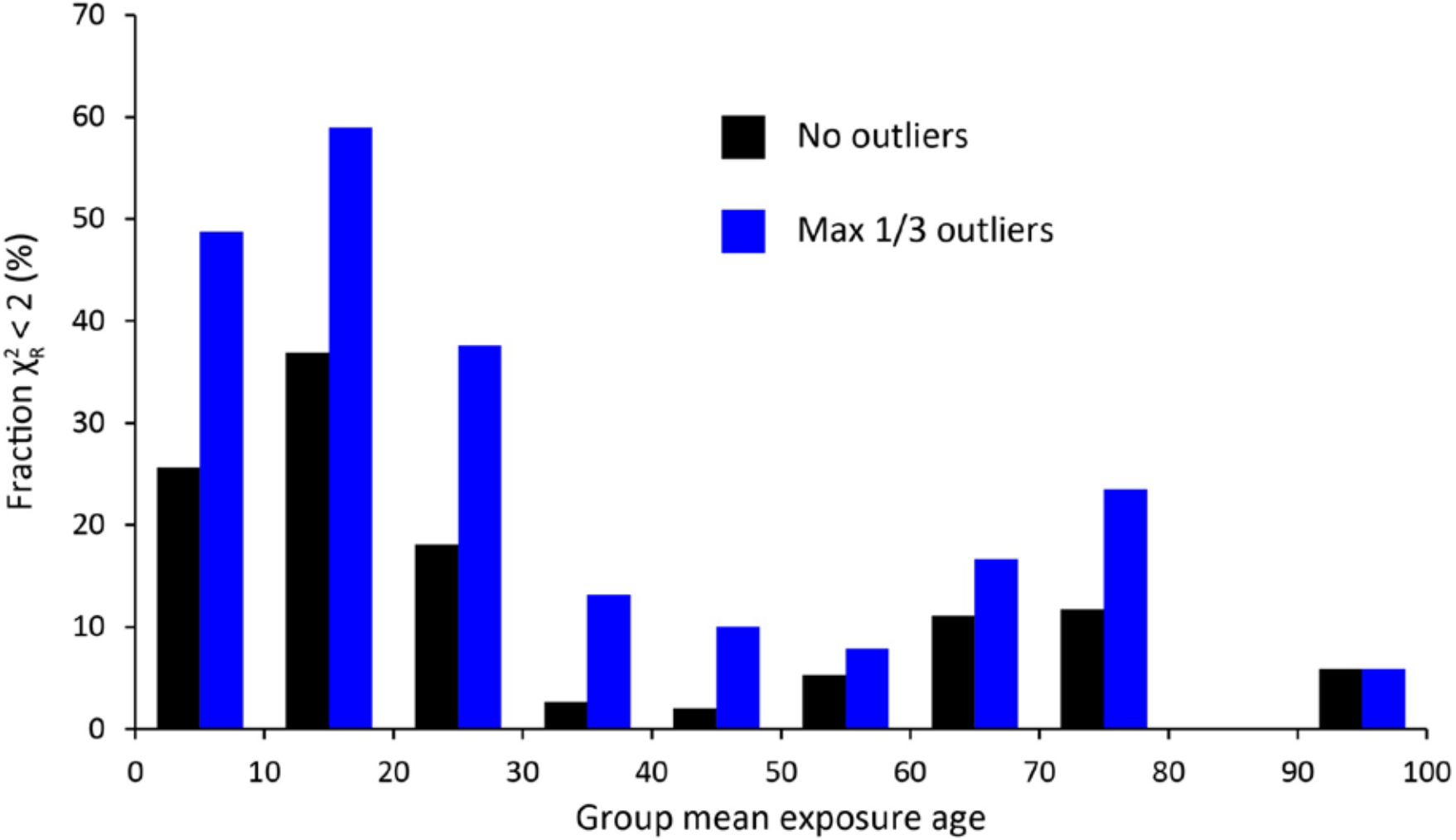
$\chi^2_R < 2$ (no outliers): 24%

$\chi^2_R > 2$

$\chi^2_R < 2$ (max 1/3 outliers): 41%

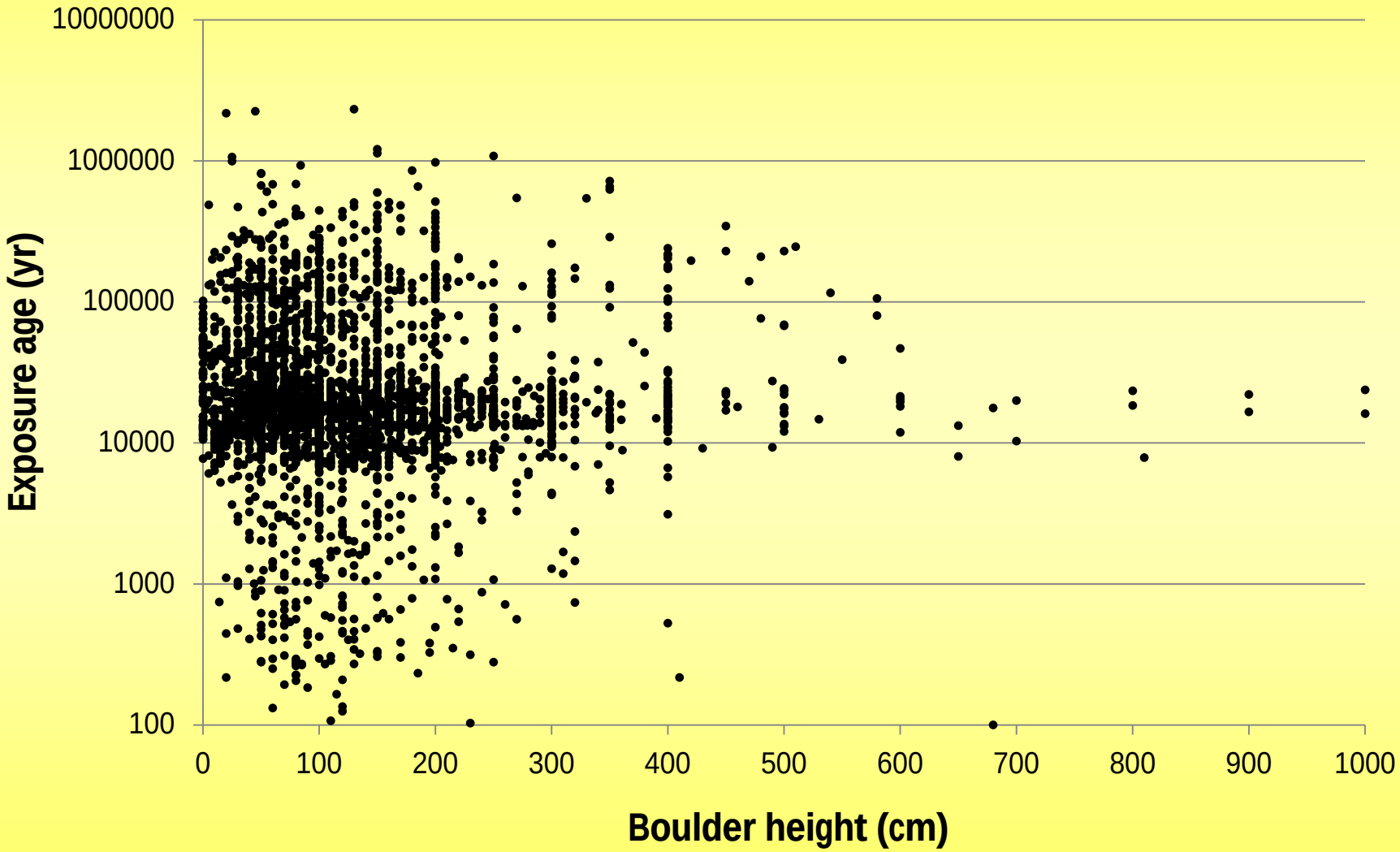


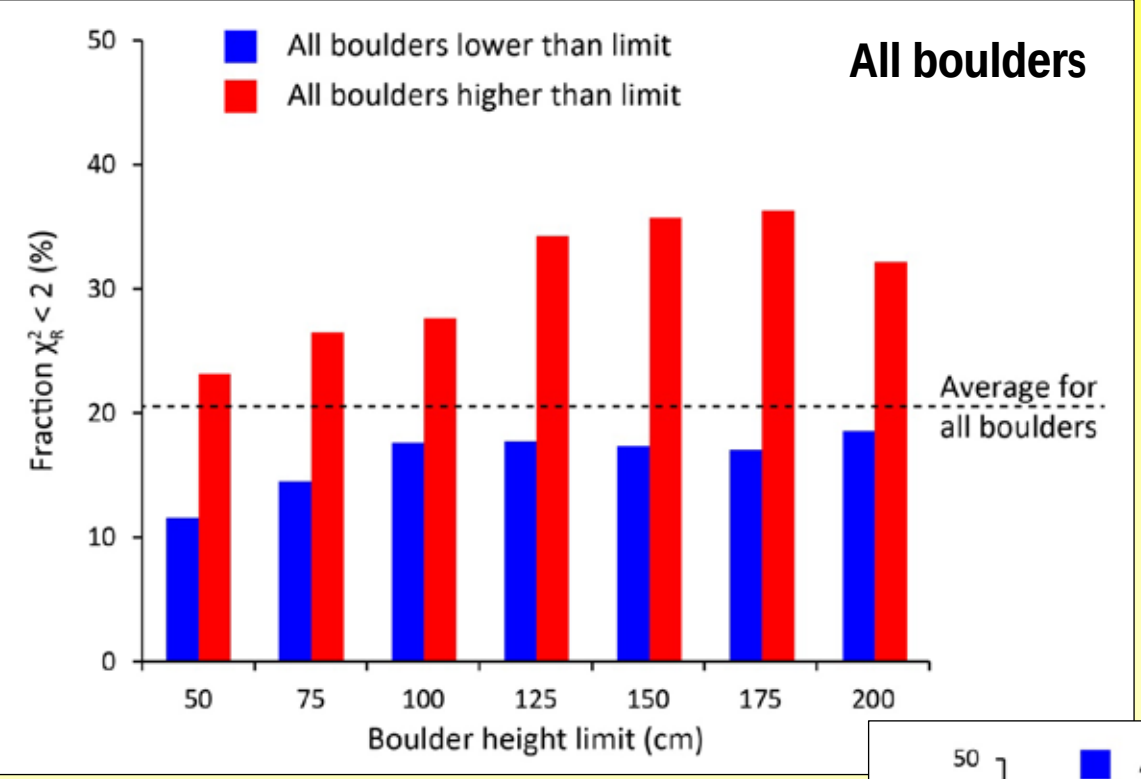
More scatter > 30 ka



Boulder height

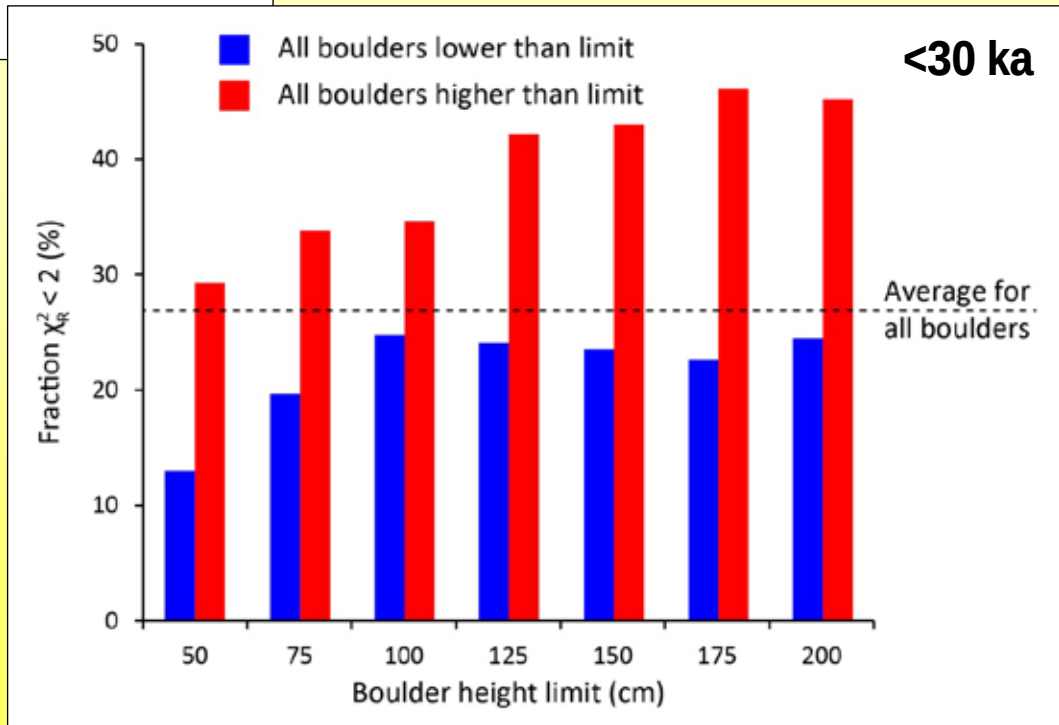
3510 boulders from 1091 boulder groups with published height and ^{10}Be exposure age





Boulder height

Groups of high boulders yield somewhat better clustering than low boulders!



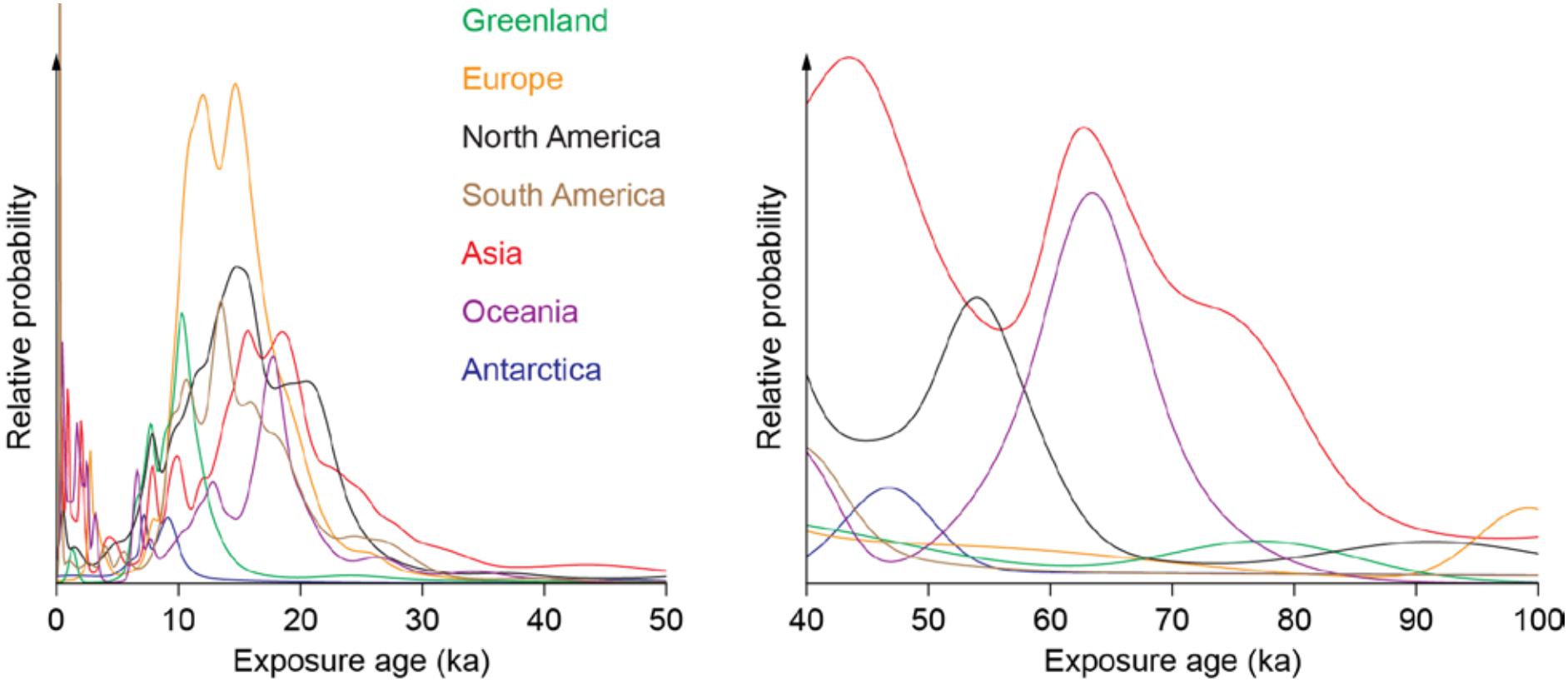
Picking out the well-clustered ages

Minimum 3 samples per group

$\chi^2 < 2$ OR $\sigma < 0.1\ \mu$

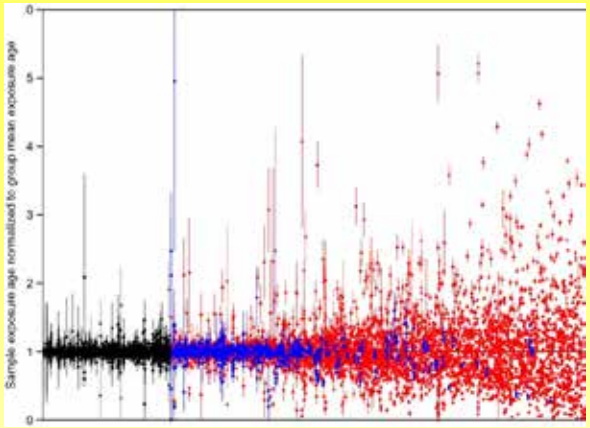
Maximum 1/3 outliers

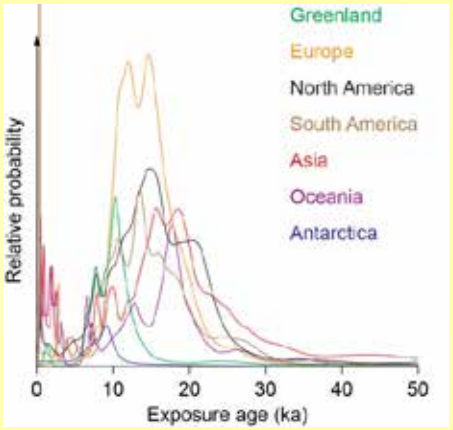
N = 771 groups

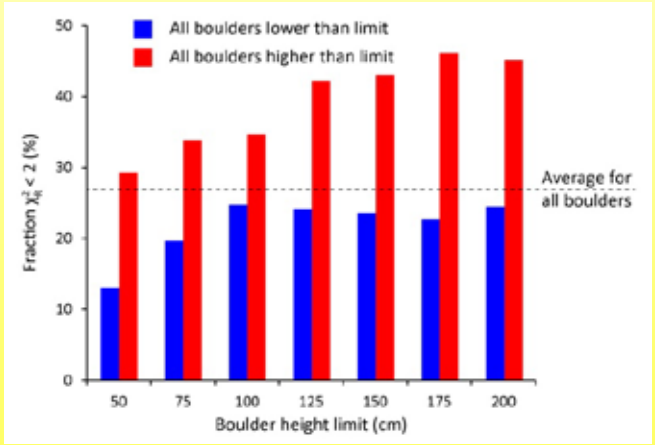


Summary

- **Scattered exposure ages are more common than well-clustered exposure ages**
- **Well-clustered exposure ages are almost always <30 ka**
- **Boulder size matters (a bit) – higher boulders commonly yield better age clustering**
- **The dataset will be made available online and kept updated**







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Thank you!