Glacial exposure ages

insights from a global compilation

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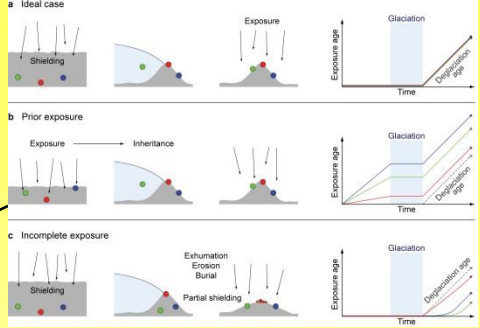
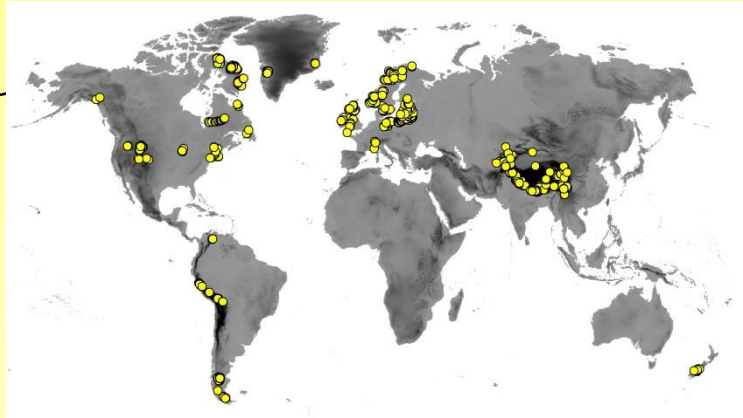
Outline

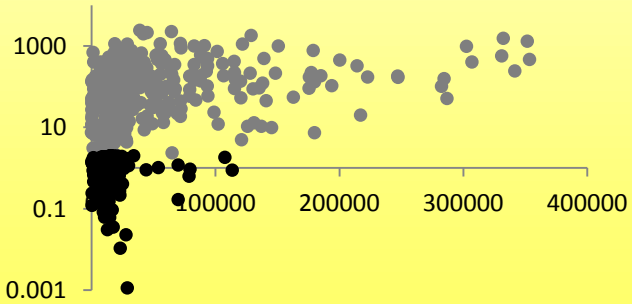


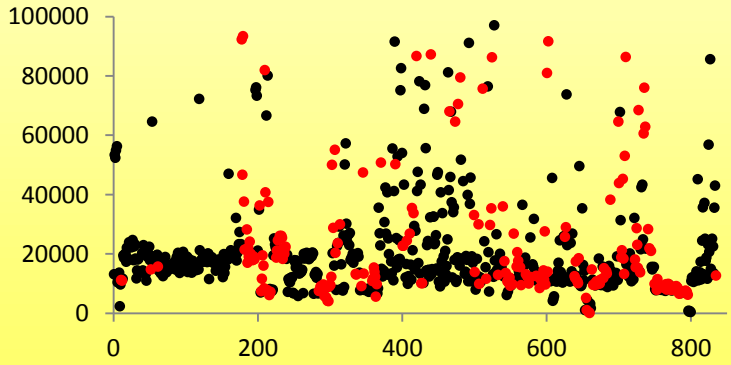
Introduction

Exposure age compilation



Exposure ages and statistics

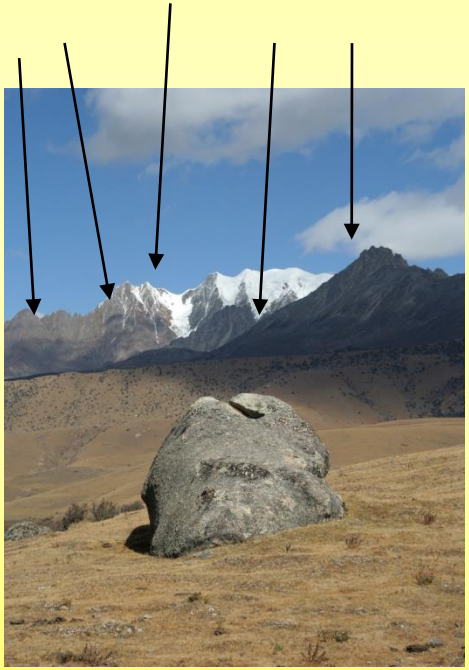




Glacial exposure dating

Glacial erosion
Shielding from cosmic rays

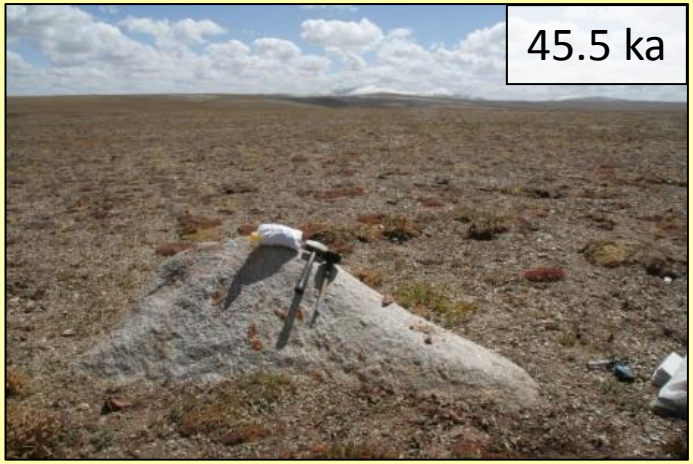
Full exposure to cosmic rays
(no post-depositional shielding)



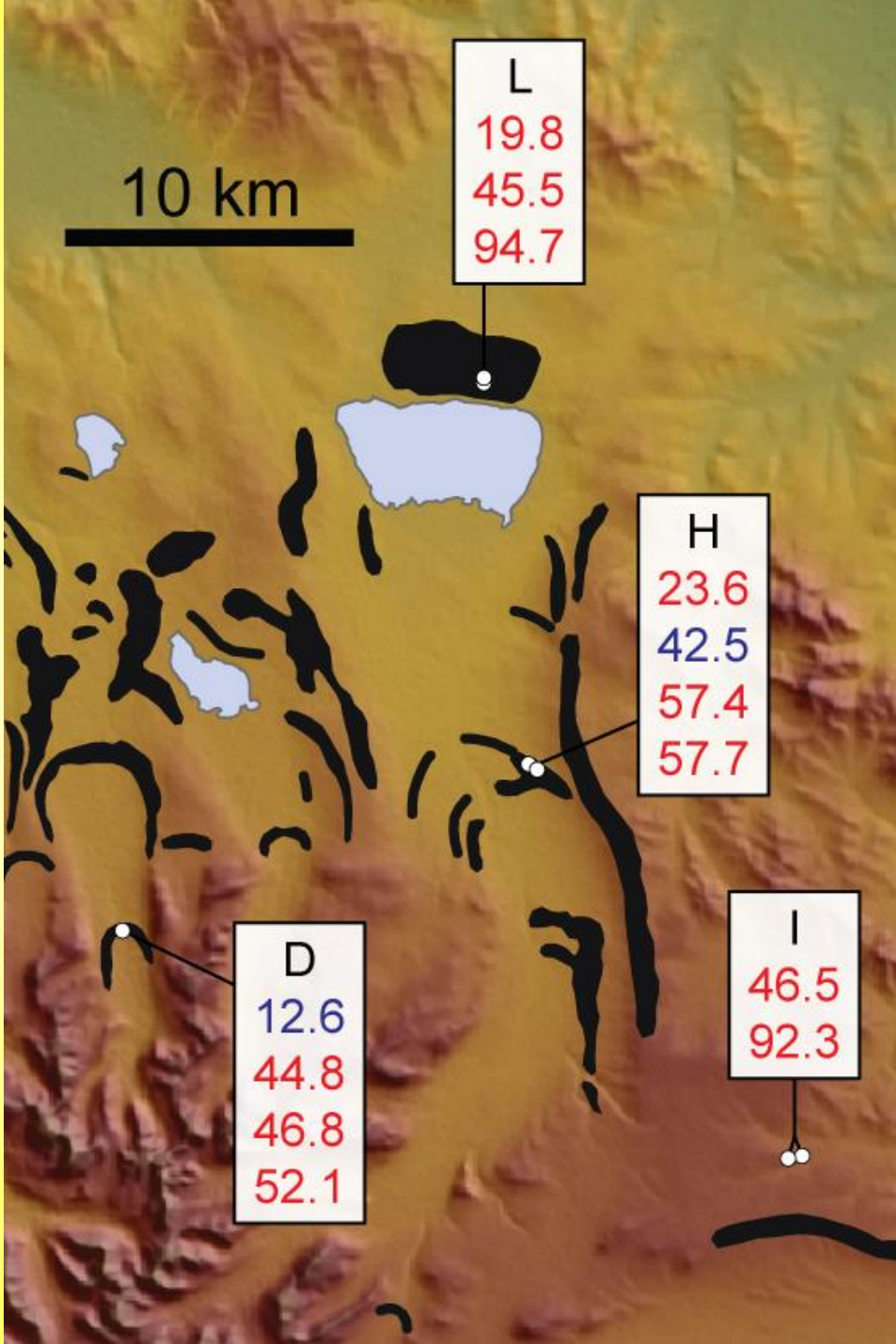
Sampling

Correct age ???

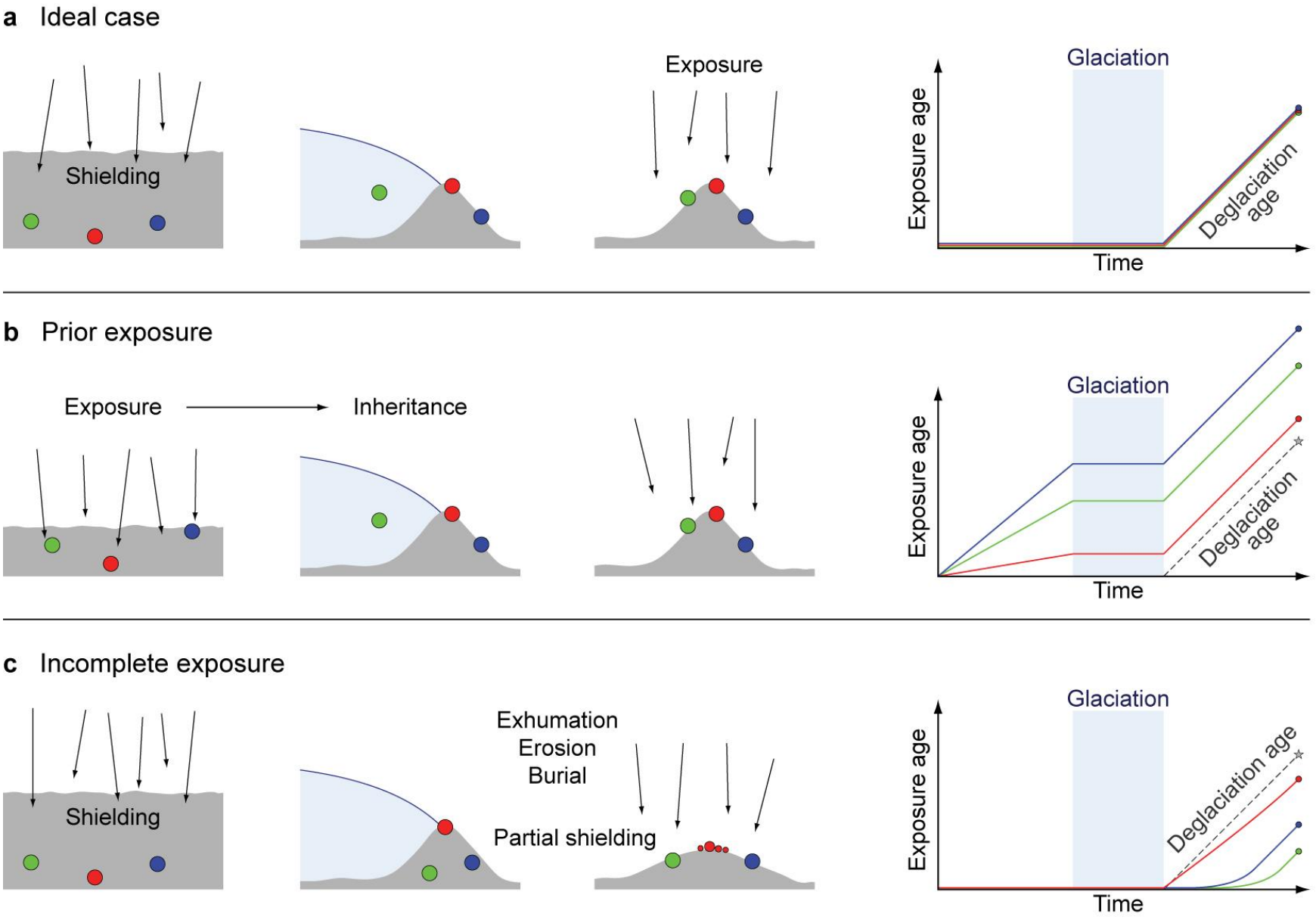

94.7 ka


45.5 ka


19.8 ka


10 km
L
19.8
45.5
94.7
H
23.6
42.5
57.4
57.7
D
12.6
44.8
46.8
52.1
I
46.5
92.3

Glacial exposure dating – problems



Exposure age compilation

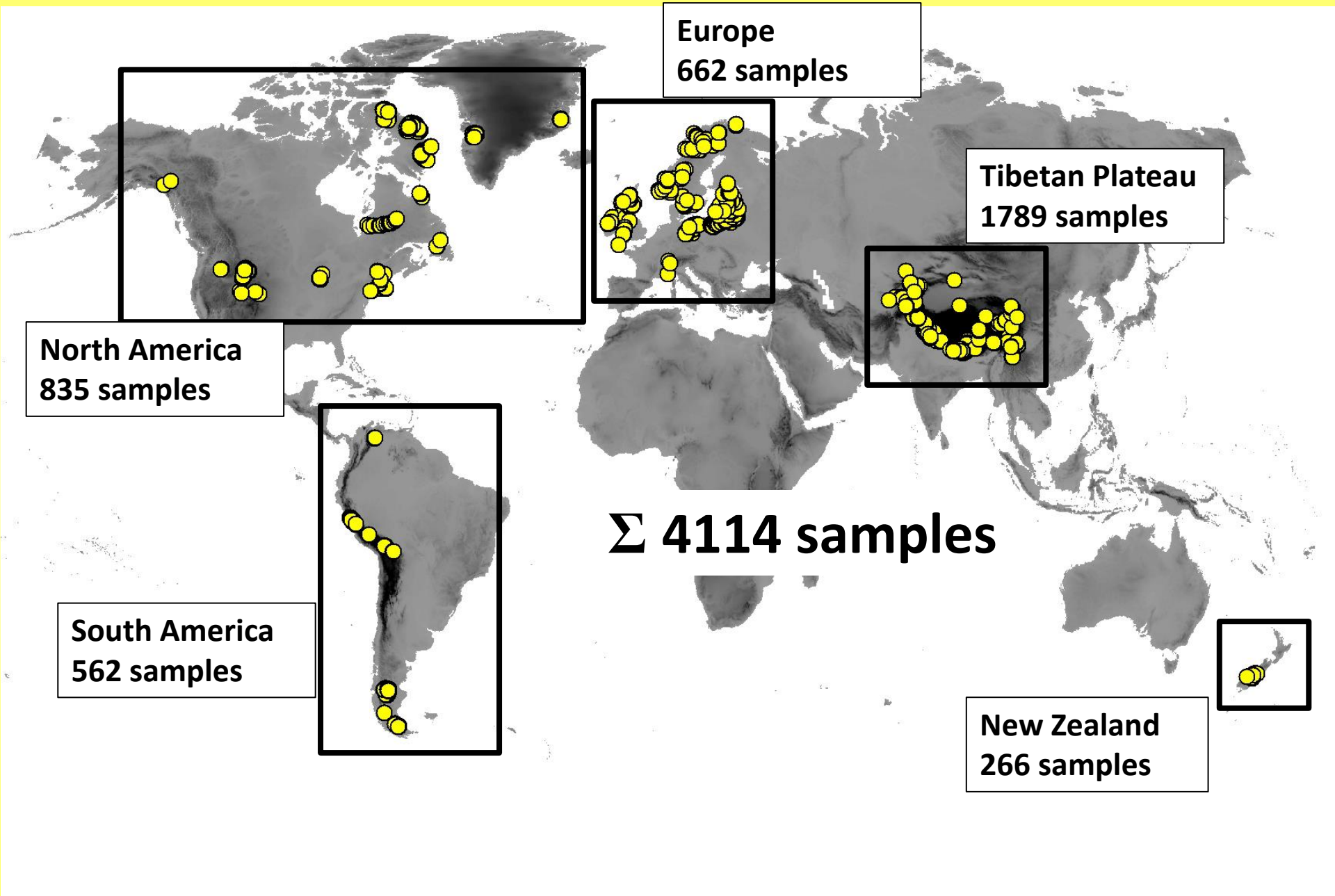
Sample information extracted from publications

Lat, longitude, altitude, sample thickness, sheilding… **^{10}Be standard**

All samples divided into glacial landform/deposit groups

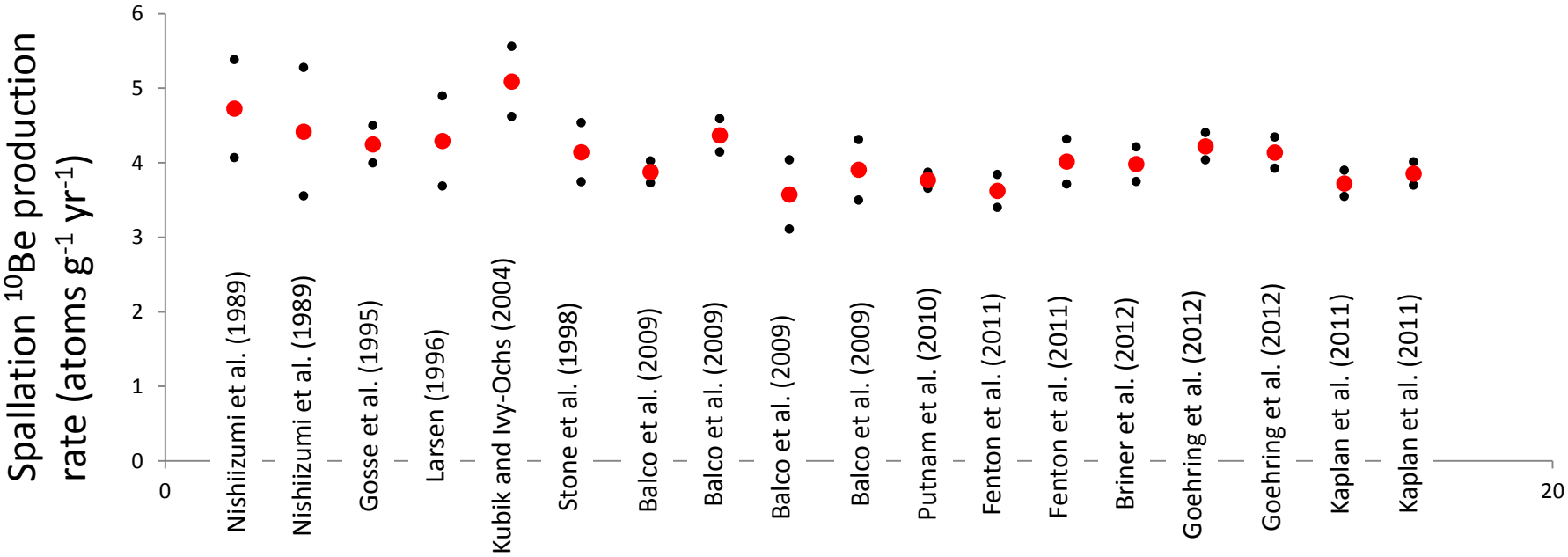
Sample type	Sample no	Group no	Sample	Latitude (degrees)	Longitude (degrees)	Altitude (m a.s.l.)	Altitude flag	Thickn (cm)	Density (g/cm^3)	Topogr shielding	Erosion (cm/yr)	^{10}Be conc (atoms/g)	^{10}Be uncert (atoms/g)	^{10}Be standard
boulder	1103	340	TB-09-79	29.8461	99.96567	4455	std	4	2.7	0.9993936	0	6664799	115631	07KNSTD
boulder	1104	341	TB-09-74	29.85743	99.9531	4339	std	4	2.7	0.9976155	0	992215	39244	07KNSTD
boulder	1105	341	TB-09-75	29.85673	99.95308	4313	std	3	2.7	0.9976155	0	1184282	33861	07KNSTD
boulder	1106	341	TB-09-76	29.85655	99.95317	4311	std	4	2.7	0.9976155	0	1260059	46121	07KNSTD
boulder	1107	342	TB-09-62	31.0313	99.70825	4371	std	3	2.7	1	0	9387503	184244	07KNSTD
boulder	1108	342	TB-09-63	31.03112	99.7082	4369	std	3	2.7	1	0	8947551	208913	07KNSTD
boulder	1109	342	TB-09-64	31.03253	99.7082	4379	std	5	2.7	1	0	7104294	218367	07KNSTD
boulder	1110	342	TB-09-65	31.03225	99.70828	4373	std	2	2.7	1	0	8647890	190875	07KNSTD
boulder	1111	343	TB-09-56	31.02635	99.72408	4258	std	3	2.7	0.9992542	0	8212087	182648	07KNSTD
boulder	1112	343	TB-09-57	31.026	99.7237	4250	std	4	2.7	0.9992542	0	8192745	204919	07KNSTD
boulder	1113	343	TB-09-58	31.0239	99.72135	4233	std	3	2.7	0.9998234	0	5551872	131718	07KNSTD
boulder	1114	344	TB-09-02	30.86815	99.64302	4043	std	3	2.7	0.9976586	0	8984509	256643	07KNSTD
boulder	1115	344	TB-09-03	30.86843	99.64295	4036	std	3	2.7	0.9976586	0	10472668	272273	07KNSTD
boulder	1116	344	TB-09-04	30.86763	99.6377	4063	std	3	2.7	0.9992041	0	7124691	114697	07KNSTD
boulder	1117	345	TB-09-20	30.18708	99.7731	4241	std	3	2.7	0.999773	0	3671694	109843	07KNSTD
boulder	1118	346	GA24	28.232	85.188	4490	std	3	2.7	0.99	0	317800	32400	NIST_27900
boulder	1119	346	GA54	28.227	85.188	4434	std	3	2.7	0.98	0	357400	24100	NIST_27900
boulder	1120	347	GA55	28.227	85.188	4446	std	3	2.7	0.98	0	587800	65700	NIST_27900
boulder	1121	348	GA80	28.237	85.195	4622	std	3	2.7	0.99	0	8100	2100	NIST_27900
bedrock	1122	349	MAI09	28.205	85.208	3510	std	3	2.7	0.79	0	361300	32000	NIST_27900
bedrock	1123	350	MAI26	28.213	85.19	4125	std	3	2.7	0.94	0	303300	34200	NIST_27900
bedrock	1124	350	GA95	28.222	85.19	4150	std	3	2.7	0.95	0	385300	35600	NIST_27900
boulder	1125	351	SK05-12	61.877	6.9237	761	std	0	2.7	0.9604	0	87000	9000	NIST_Certified
boulder	1126	351	SK05-11	61.8736	6.9252	885	std	0	2.7	0.9603	0	13000	3000	NIST_Certified
boulder	1127	352	SK05-10	61.8701	6.9259	947	std	0	2.7	0.9604	0	15000	4000	NIST_Certified
boulder	1128	352	SK05-8	61.8687	6.9294	1028	std	0	2.7	0.9604	0	105000	9000	NIST_Certified
boulder	1129	352	SK05-9	61.8687	6.9294	1028	std	0	2.7	0.9702	0	162000	11000	NIST_Certified

(Global) glacial ^{10}Be exposure age compilation

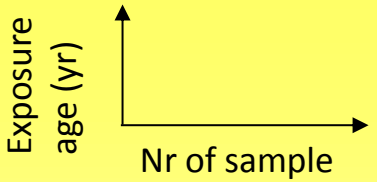


Recalculation of exposure ages

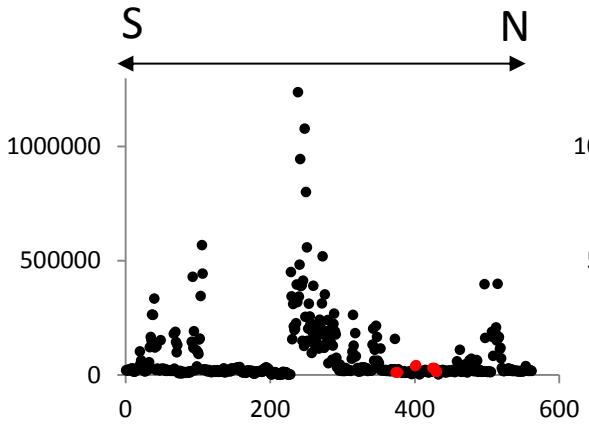
All exposure ages recalculated using CRONUS onlince code with Lal/Stone time-dependent production rate scaling and a reference production rate of 4.11 +/- 0.39 atoms g^{-1} yr^{-1}



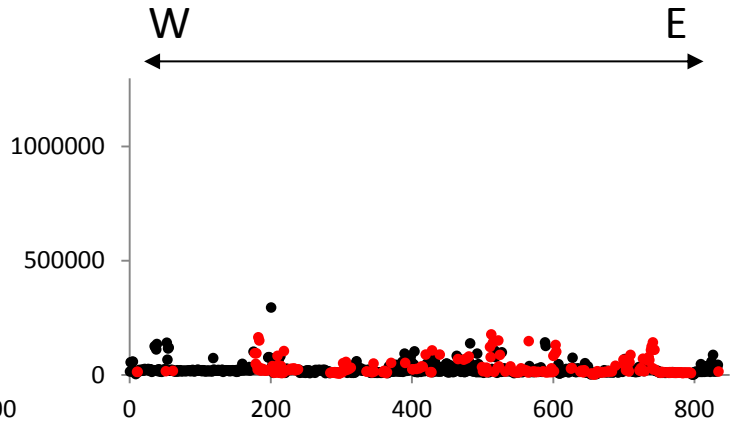
Exposure ages



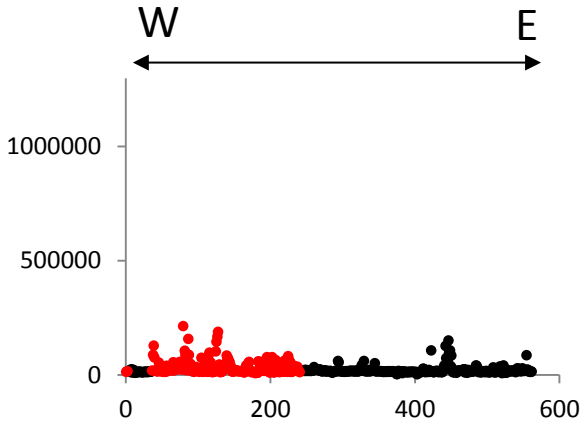
South America

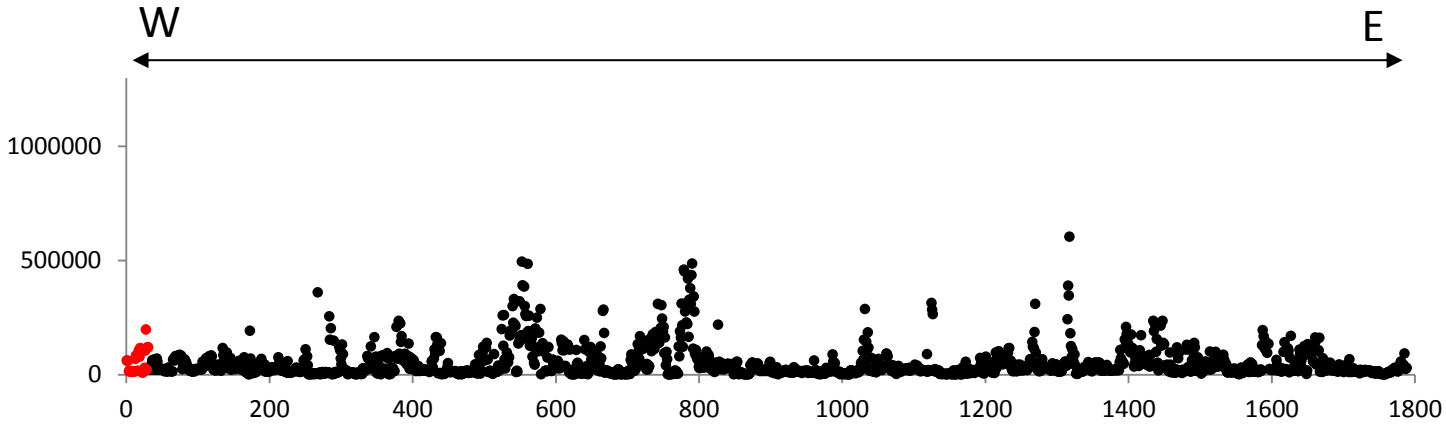


North America

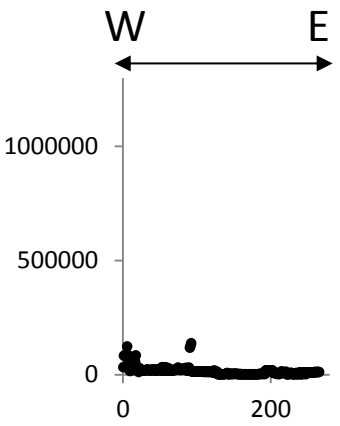


Europe



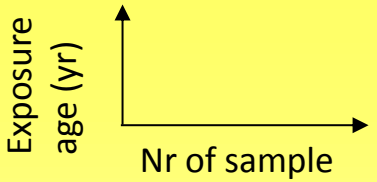


Tibetan Plateau

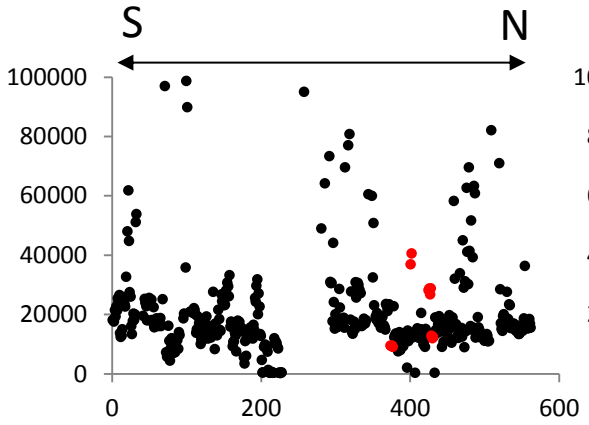


New Zealand

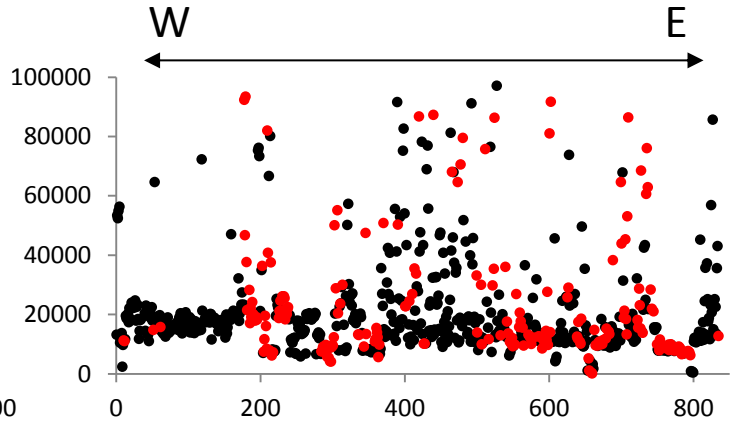
Exposure ages



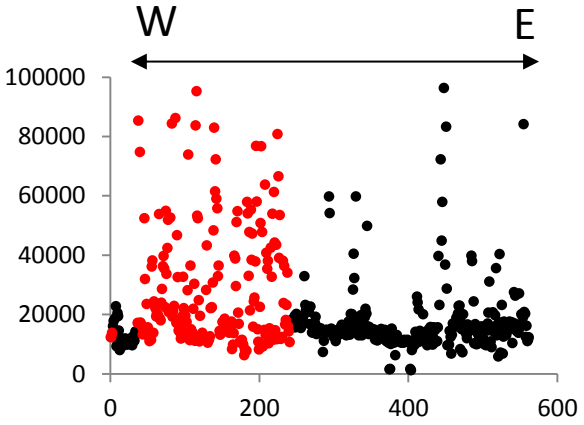
South America

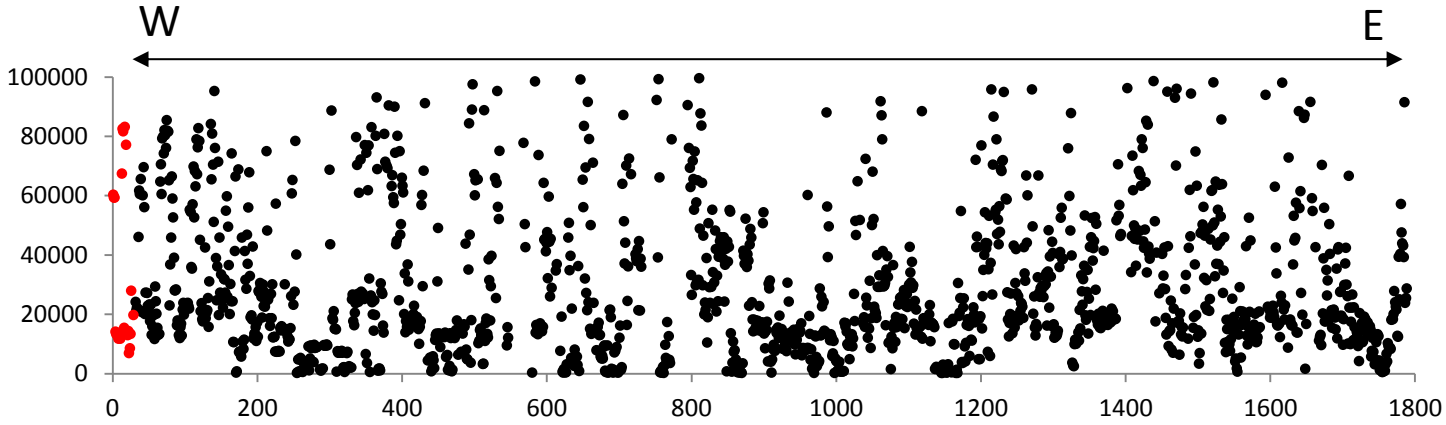


North America

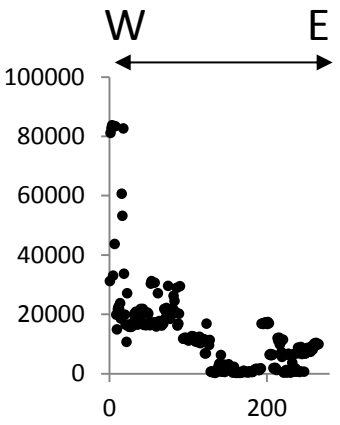


Europe



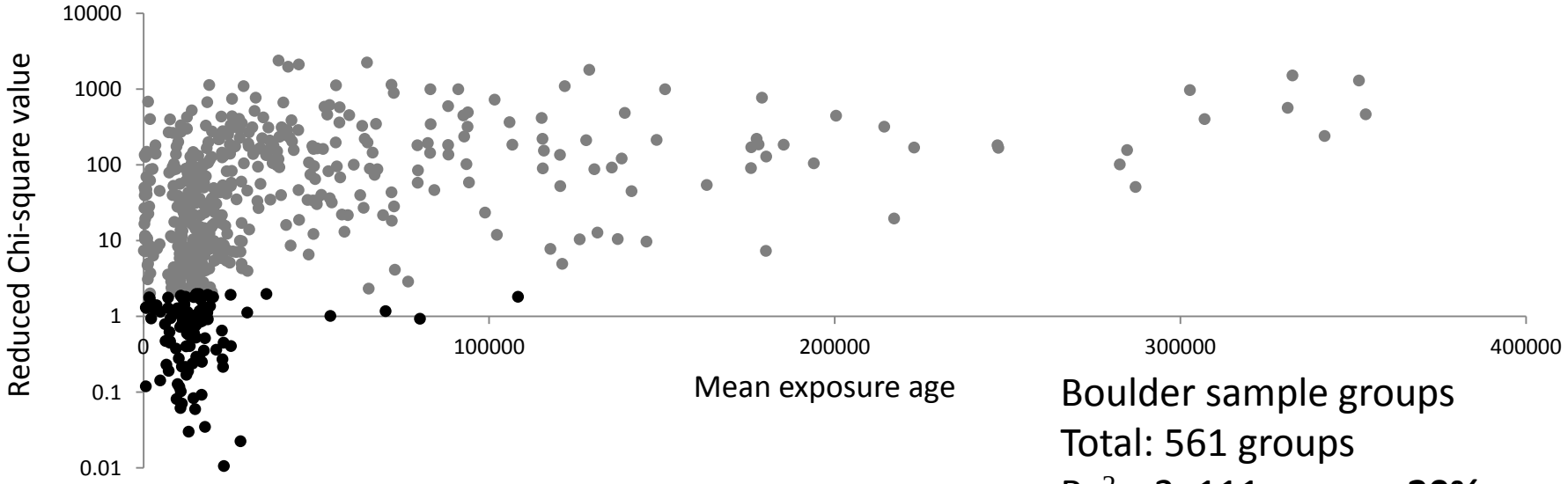


Tibetan Plateau

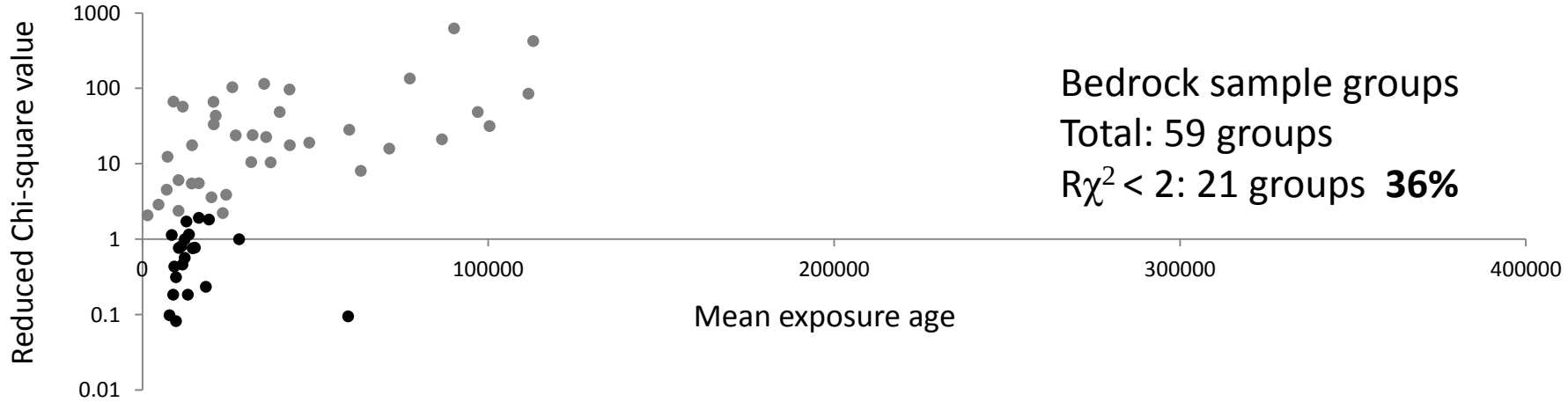


New Zealand

Reduced chisquare

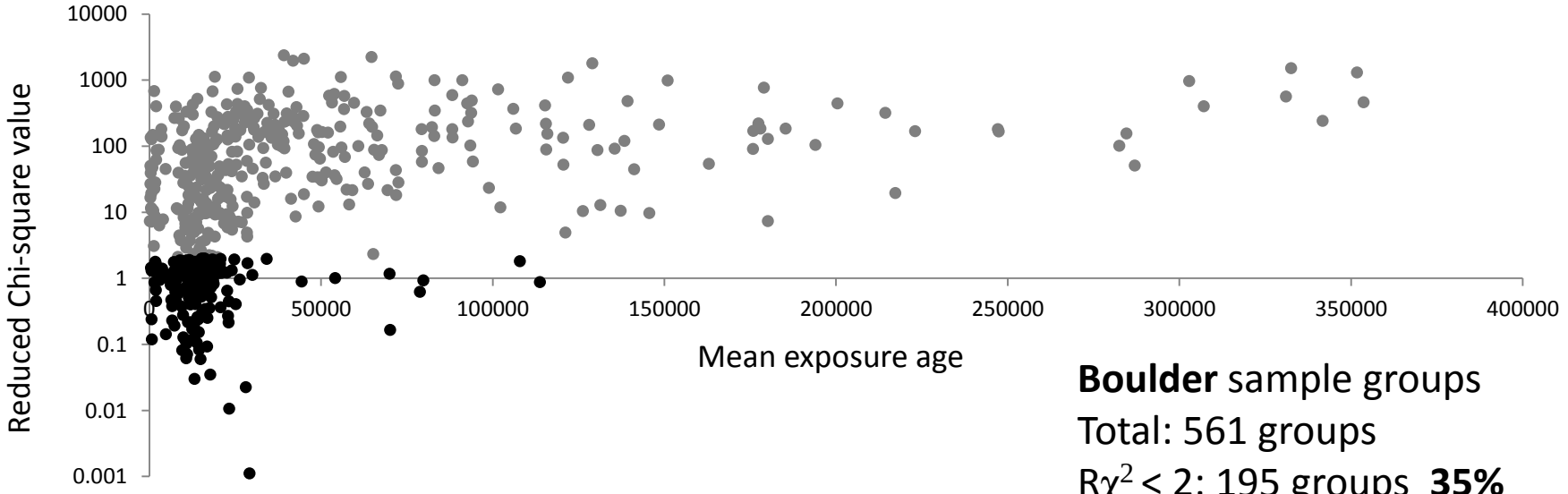


Boulder sample groups
Total: 561 groups
Rχ^2 < 2: 111 groups **20%**

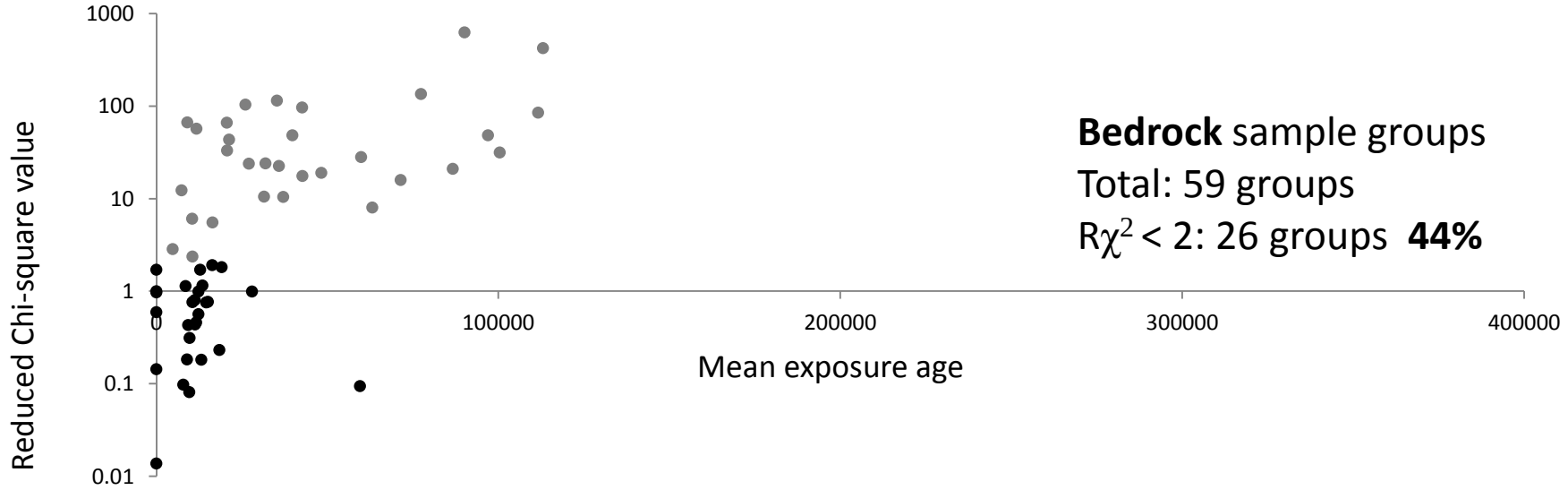


Bedrock sample groups
Total: 59 groups
Rχ^2 < 2: 21 groups **36%**

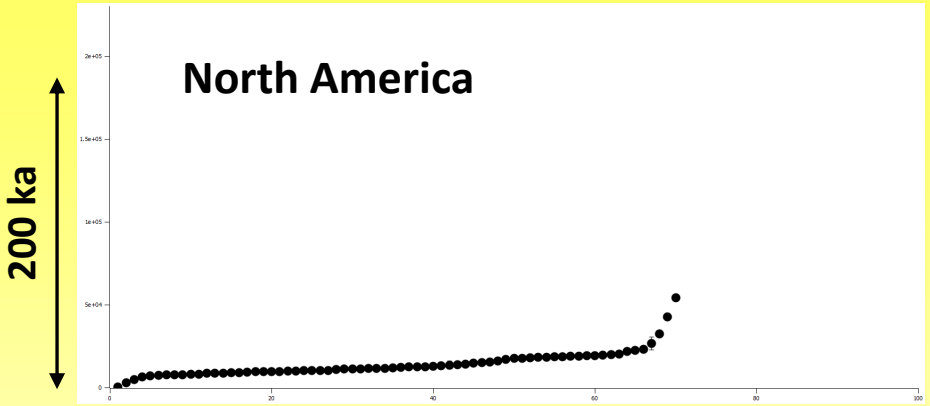
Reduced chisquare

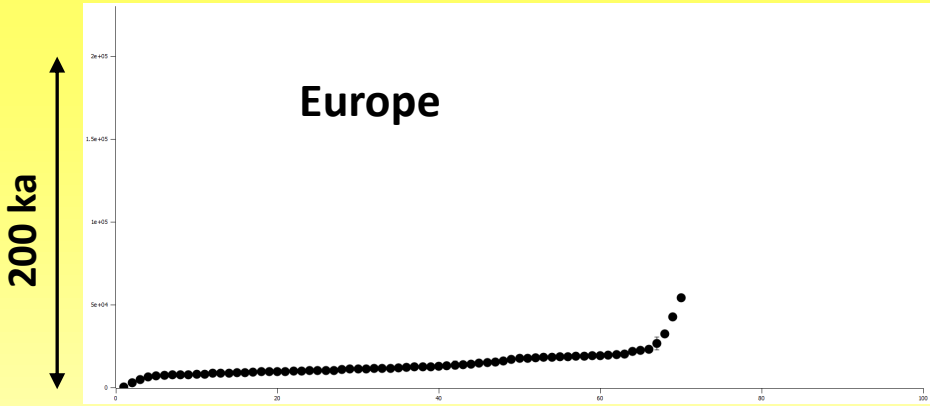


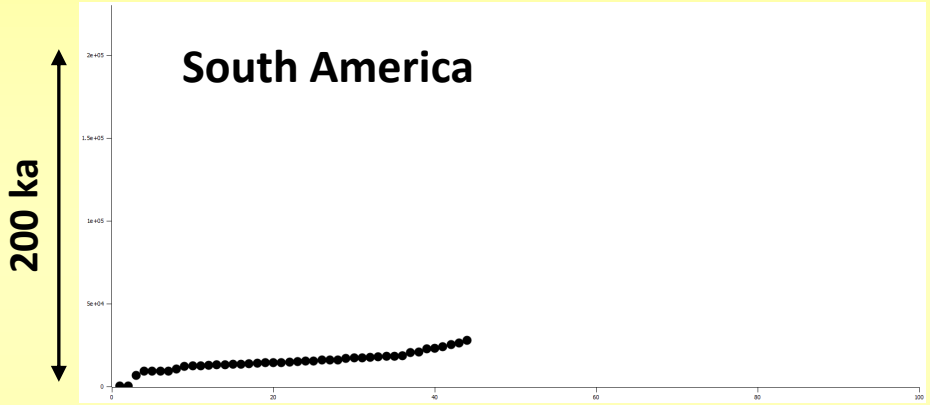
Boulder sample groups
Total: 561 groups
Rχ^2 < 2: 195 groups **35%**

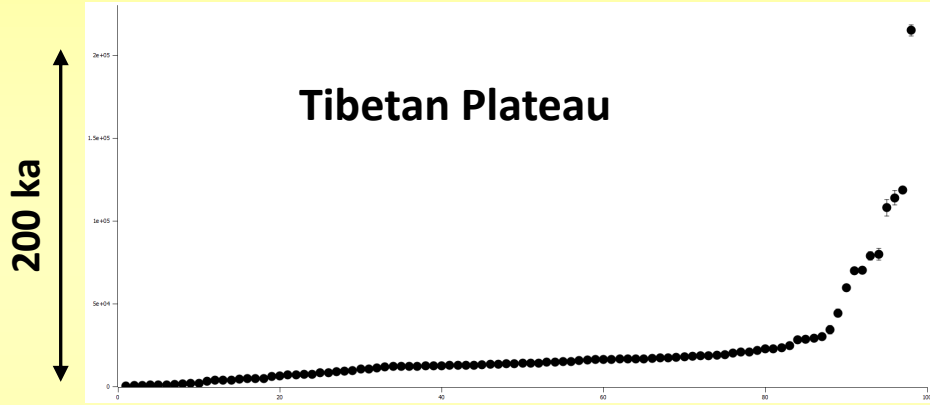


Bedrock sample groups
Total: 59 groups
Rχ^2 < 2: 26 groups **44%**

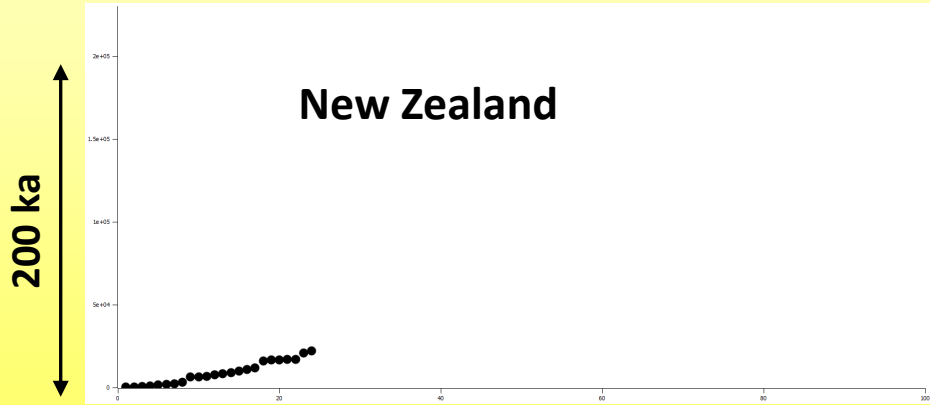


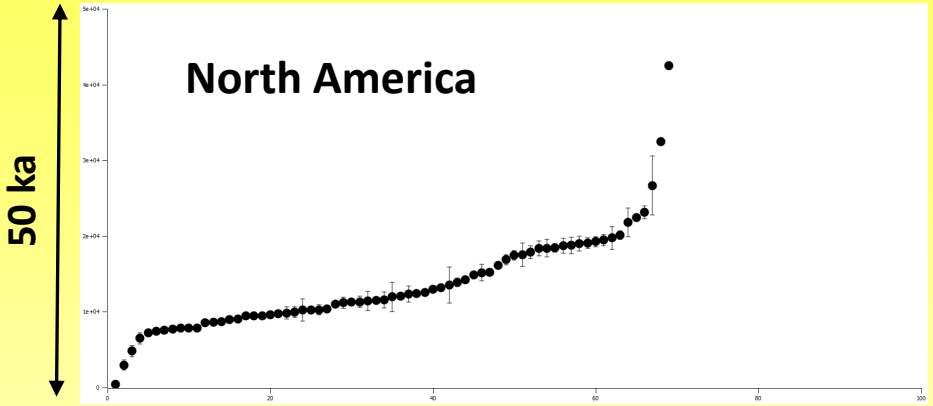


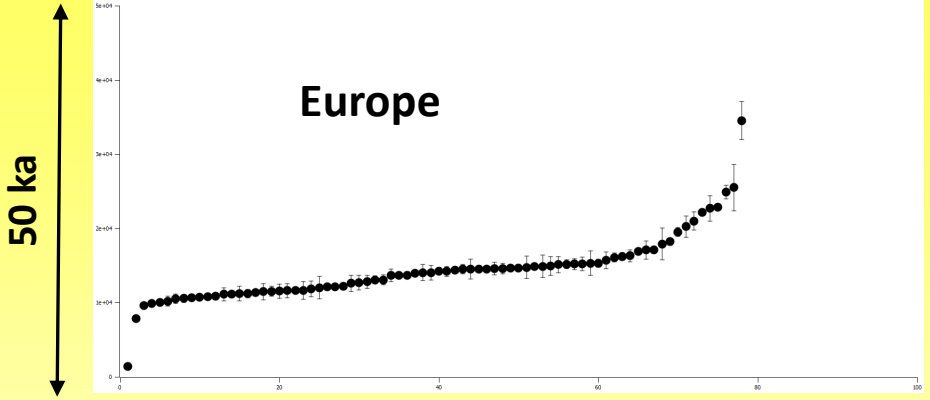


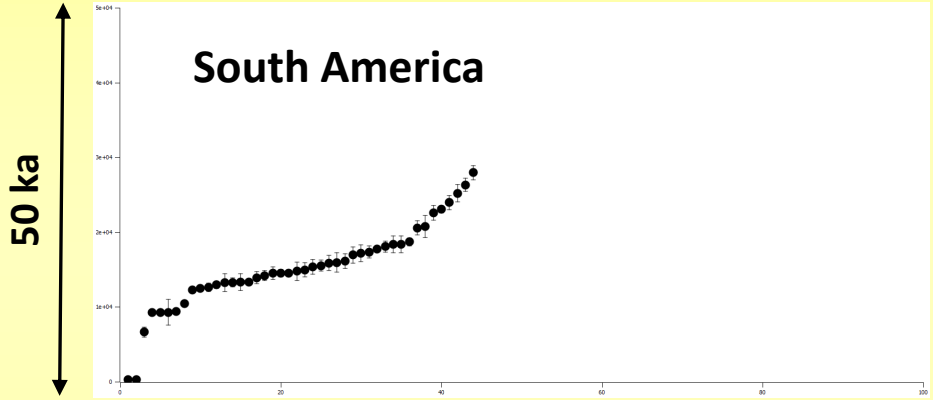


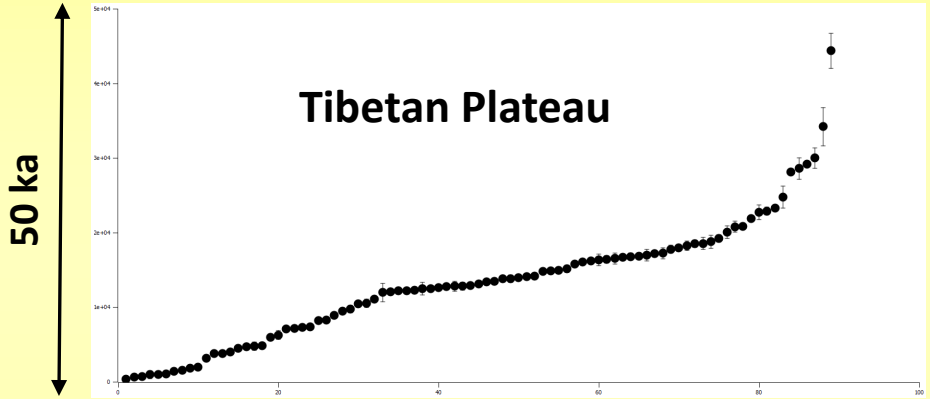
Error weighted mean exposure ages for groups with $R\chi^2 < 2$



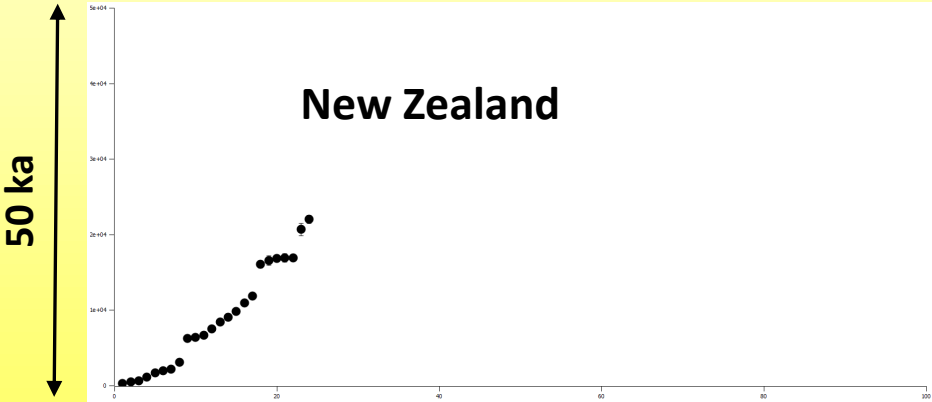








Error weighted mean exposure ages for groups with $R\chi^2 < 2$



Conclusions

- **Many (perhaps most) glacial exposure ages do not show the deglaciation age**
- **Sample groups with good clustering are mostly from the last major deglaciation**


Thank you!