Apatite (U-Th)/He Methods:
Individual apatite grains with half-widths >40 μm were hand-picked and analyzed for (U-Th)/He age using standard procedures at Caltech for laser heating (Farley and Stockli, 2002). Typically 4 single-grain analyses (Table DR2) were used to calculate mean ages (Table DR-1). Age uncertainties are reported as the 2σ standard error of replicate analyses for individual samples using an average standard deviation for each data subgroup (7% for the Laji Shan vertical transect, 13% for the Jishi Shan vertical transect, 16% for the isolated samples).

Apatite Fission-Track Methods:
Apatite fission-track analyses were conducted by Paul O'Sullivan at Apatite to Zircon, Inc. and by Dewen Zheng at the Chinese Institute of Geology. Mounts of apatite grains from 10 samples were analyzed for fission-track ages using standard procedures at Apatite to Zircon, Inc. using the laser-ablation inductively-coupled mass spectrometer method (Parra et al., 2009; Donelick et al., 2005). Spontaneous fission tracks in apatite were etched in 5.5N HNO_3 at 21°C for 20 s. Typically 25 single-grain analyses (Table DR3) were used to calculate ages (Table DR1), which are reported with a 2σ uncertainty. We use pooled ages in our study, unless the distribution of single-grain ages fails the chi-square test, in which case the central age is used. Failure of the chi-square test with monocompositional apatite suggests prolonged residence in the partial annealing zone, which supports our interpretation of slow early Cenozoic cooling. Additionally, about 125 confined track lengths were measured per sample (Table DR4). Apatite grains from five Jishi Shan samples were analyzed for fission-track ages at the Chinese Institute of Geology using the analytical procedures outlined in (Wang et al., 2003) for the external detector method. Spontaneous fission tracks in apatite were etched in 7%HNO_3 at 20°C for 35 s. Typically 25 single-grain analyses (Table DR5) were used to calculate pooled ages (Table DR1). Given 1) inconsistent AFT track lengths measured by two analysts using different etching conditions, and 2) the observation that length data for some samples contradicts the observed age-elevation data that summarizes multiple thermochronometers from many samples collected over ~1 km of relief, we focus on the age-elevation cooling trends and do not consider track-length measurements at all in our analysis.

Forward Modeling Methods:
We utilized the forward modeling function in HeFTy 1.6.7.43 (Ketcham, 2005) to calculate AHe and AFT thermochronometer ages based on a prescribed thermal history. We subjected "samples" at different depths in a column of rock to the same relative cooling history. Each of seven HeFTy forward models in a specified model run were identical in their timing, durations, magnitudes, and rates of cooling, but different in that models were offset by 5°C relative to adjacent models to simulate different depths in the same column of rock. We assume a linear geothermal gradient and neglect the advection of heat due to erosion rate changes (see below for rationale). AHe and AFT ages were computed simultaneously for each 5°C increment in a 30°C parcel (1200-1500 m thick column) of rock.

Age calculations were made within HeFTy using the RDAAM apatite (U-Th)/He model (Flowers et al., 2009) and the Ketcham et al. apatite fission track model (2007). Model ages were calculated for typical apatite values for eU, radius, and dpar from our samples in the Laji

Shan (45, 50, 1.85, respectively) and Jishi Shan (78, 50, 2.0). We varied the magnitude of rapid cooling, onset time of rapid cooling, and cooling rates iteratively over the course of 36 (Laji Shan) and 33 (Jishi Shan) model runs to find acceptable fits to the transect age-elevation data. During the course of forward modeling, we discovered that the "magnitude of rapid cooling (in °C)" was the model parameter with the greatest influence on accurate predictions of the shape of the AHe and AFT age distributions. The magnitude of rapid cooling needed to be sufficiently large to predict the steep AHe age-elevation gradients, while at the same time being small enough to predict the shallow AFT age-elevation gradients for the same set of samples (Fig. 3). Thus, our first step was to iterate through a series of forward model runs to determine the magnitude of rapid cooling that best predicted the shape of the AHe age-elevation trend simultaneously with the AFT trend. Afterwards we explored a range of onset times of rapid cooling and durations of rapid cooling (i.e. rapid cooling rates), as well as similar parameters for the slow cooling episode(s), to fine-tune the model. One caveat is that direct comparison of forward model AFT age predictions to observed AFT ages for samples that have failed the chi-square test may not be suitable.

To project our thermal model results onto the thermochronometer age-elevation plots (Fig. 3) we need to use an appropriate geothermal gradient. Local heat flow measurements suggest that the modern geotherm in this area is 20-30°C/km (Hu et al., 2000). Within this range of geothermal gradients, the best fit to the Laji Shan age-elevation results is a geotherm of 20°C/km, whereas the best fit to the Jishi Shan is 25°C/km. A geotherm approximated as constant is appropriate because the relatively small magnitudes and rates of accelerated Miocene erosion of the Laji Shan and Jishi Shan do not significantly affect the thermal structure of the ranges. Within the range of feasible values, the combination of erosion rate (1 mm/yr) and cooling duration (3 Myr) that conspire to induce the maximum possible thermal perturbation for the Laji Shan suggest a <25% increase in geothermal gradient (Ehlers, 2005). Similar types of values for the Jishi Shan (0.2 mm/yr, 13 Myr) suggest a <10% increase in gradient.

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Table DR1. Apatite mean (U-Th)/He ages and fission track ages

Sample	latitude	longitude	elevation (m)	AHe mean age (Ma)	error (2σ)	AFT age [@] (Ma)	error[$] (2σ)	mean radius (um)	mean eU (ppm)
Laji Shan transect									
upper thrust fault hanging wall									
LJ8-D	36.1781	102.6111	3452	21.8	1.9	75.2	6.2	45	59
LJ8-E	36.1837	102.6201	3268	22.7	2.4			48	49
LJ8-F	36.1841	102.6266	3026	21.9	1.9			53	31
LJ8-G	36.1844	102.6305	2918	22.6	1.9	52.5	6.4	51	24
LJ8-B	36.1714	102.6296	2736	18.9	1.6			52	46
LJ8-C	36.1713	102.6328	2575	17.6	1.3	37.8	3.8	49	61
lower thrust faults hanging walls									
LJ8-H	36.1827	102.6387	2686	28.3	2.1	64.6	3.3	55	33
LJ8-J	36.1809	102.6443	2526	36.3	2.7	58.9	2.7	55	11
Jishi Shan transects									
cJS1									
LJ9-A	35.7678	102.7300	2933	8.1	1.1	23.4	2.0	42	94
LJ9-B	35.7688	102.7364	2743	9.1	1.2			49	58
LJ9-H	35.7460	102.7328	2645	8.0	1.0			46	177
LJ9-C	35.7671	102.7375	2596	7.9	1.0	14	2.6	58	28
LJ9-I	35.7508	102.7358	2593	10.3	1.3			53	246
LJ9-F	35.7662	102.7390	2545	8.3	1.1			41	120
LJ9-J	35.7531	102.7407	2490	8.6	1.1			58	129
LJ9-K	35.7574	102.7439	2400	7.2	0.9	18.1	1.2	55	214
LJ9-D	35.7647	102.7411	2432	5.4	0.7	18.1	3.4	69	14
LJ9-G	35.7630	102.7430	2386	5.4	0.8	18.3	3.4	51	16
LJ9-E	35.7649	102.7460	2313	#					
nJS									
JS1-D	36.0282	102.6884	3221	21.5	4.0			42	7
JS1-E	36.0282	102.7085	3032	18.9	2.7			42	7
JS1-3	36.0300	102.7107	2944	10.6	2.0			44	12
cJS2									
MC6	35.8062	102.6970	2506	6.9	1.3	15.0	1.6	51	27
z7	35.7957	102.6911	2627			22.2	2.4		

sJS									
MC8	35.5570	102.8630	2574	9.9	0.9	34.1	7.4	56	15
z4	35.5545	102.8126	2998			39.8	4.0		
z5	35.5699	102.7870	3240			36.0	3.6		
Regional samples									
X10	35.8625	102.4976	1955	#					
LJ2-E	36.1193	102.5283	3089	73.6	13.6				
intrabasinal basement									
H3-C	36.0987	102.1057	2889	95.9	17.7				
JZ4	35.9459	102.0477	2015	142	32.2				
MC9	35.7727	102.9570	2146	189	19.1				

Notes:

Replicates display poor reproducibility with standard deviation >65%. No mean age reported.

@ AFT pooled age reported unless sample failed the chi-squared test, in which case the central age is reported

$ Pooled age error reported. Central age error ≥ pooled age error (e.g. Galbraith and Laslett, 1993)

AHe analyses reported in Table A2

AFT analyses reported in Tables A3, A4, and A5

Table DR2. Single-grain apatite (U-Th)/He analyses

Sample	U (ppm)	Th (ppm)	He (nmol/g)	mass (μg)	Ft ##	radius (μm)	length (μm)	Raw Age (Ma)	Corr Age (Ma)	Sm (ppm)
Laji Shan transect										
LJ8-D(a)	42	54	4.5	1.8	0.68	42	194	15.2	22.3	-
LJ8-D(c)	44	54	4.8	2.0	0.70	47	166	15.6	22.2	-
LJ8-D(d)	48	73	5.2	2.5	0.70	45	238	14.8	20.9	-
LJ8-E(a)	32	35	3.7	3.4	0.73	50	258	17.2	23.4	-
LJ8-E(b)	23	31	2.5	2.5	0.71	47	213	15.6	21.9	-
LJ8-F(a)	17	30	2.0	2.2	0.69	43	219	14.8	21.3	-
LJ8-F(c)	27	33	3.3	2.9	0.77	62	227	17.5	22.7	110
LJ8-F(d)	28	29	3.1	3.0	0.75	55	217	16.3	21.8	83
LJ8-G(a)	22	25	2.6	2.6	0.72	49	200	16.9	23.6	-
LJ8-G(b)	18	19	2.1	3.6	0.76	59	192	16.9	22.4	-
LJ8-G(c)	18	21	1.9	2.4	0.70	44	234	15.4	22.0	-
LJ8-B(a)	36	38	3.3	4.0	0.76	62	194	13.4	17.5	-
LJ8-B(b)	35	41	3.4	2.8	0.73	50	209	14.1	19.4	-
LJ8-B(c)	38	40	3.7	2.3	0.71	45	214	14.1	20.0	-
LJ8-C(a)*	55	37	10.6	1.1	0.75	58	190	30.1	39.9	70
LJ8-C(b)	48	44	4.6	2.8	0.75	54	236	14.6	19.4	86
LJ8-C(d)	44	40	4.3	4.1	0.76	54	328	14.7	19.4	83
LJ8C(f)	60	60	4.5	2.3	0.69	46	158	11.0	15.9	150
LJ8C(g)	46	47	3.4	1.7	0.68	43	150	10.8	15.9	190
LJ8-H(a)	24	27	3.6	5.1	0.78	66	215	21.7	27.9	-
LJ8-H(b)	31	29	3.8	1.9	0.69	44	183	18.7	26.9	-
LJ8-H(c)	33	28	4.4	2.1	0.71	49	165	20.6	28.9	-
LJ8-H(d)	20	23	3.1	5.7	0.78	61	286	22.9	29.5	-
LJ8-J(a)	7.7	11	1.5	1.8	0.68	41	201	26.7	39.5	-
LJ8-J(b)	10	12	1.8	4.5	0.76	59	242	25.2	33.0	-
LJ8-J(c)	8.2	13	1.7	5.0	0.77	59	264	26.9	35.1	-
LJ8-J(d)	6.0	9.3	1.3	4.6	0.77	63	218	29.1	37.8	-
Jishi Shan transects										
LJ9-A(c)	61	44	2.0	0.9	0.61	40	81	5.08	8.25	180
LJ9-A(d)	92	62	2.7	1.0	0.64	40	101	4.64	7.30	300
LJ9-A(e)	83	41	2.6	1.0	0.65	43	97	5.04	7.77	290
LJ9-A(g)	92	65	3.4	1.2	0.64	46	78	5.87	9.11	200
LJ9-B(a)	12	41	0.6	1.5	0.68	46	137	4.90	7.20	190
LJ9-B(c)	50	120	2.7	2.1	0.69	48	148	6.25	9.00	190
LJ9-B(d)	43	130	2.9	2.5	0.72	55	140	7.26	10.1	160
LJ9-B(g)	36	100	2.2	1.3	0.67	47	109	6.79	10.2	120

LJ9H(a)	140	170	6.1	1.3	0.66	52	76	6.20	9.37	220
LJ9H(b)	150	170	5.2	2.2	0.69	46	156	5.13	7.40	140
LJ9H(d)	180	160	4.6	1.4	0.66	44	107	4.01	6.05	1400
LJ9H(e)	100	110	4.1	1.2	0.64	43	89	5.79	9.07	200
LJ9-C(e)	13	50	0.7	2.8	0.69	49	128	5.37	7.79	220
LJ9-C(f)	21	64	1.0	2.1	0.68	49	112	5.17	7.62	210
LJ9-C(a)	10	27	0.4	3.8	0.75	61	192	5.03	6.67	-
LJ9-C(b)	23	65	1.7	8.8	0.81	77	275	8.40	10.4	-
LJ9-C(c)	15	37	0.6	2.6	0.73	55	164	5.05	6.96	-
LJ9I(a)	200	240	9.9	3.4	0.67	43	134	7.04	10.6	100
LJ9I(b)	200	220	9.9	3.2	0.74	55	167	7.34	10.0	110
LJ9I(c	220	220	10.1	2.7	0.73	58	129	6.89	9.45	120
LJ9I(d)	160	220	9.5	3.8	0.75	57	203	8.29	11.1	100
LJ9-F(a)	69	180	3.2	1.8	0.63	40	108	5.27	8.38	90
LJ9-F(b)	50	160	2.0	1.3	0.64	40	122	4.16	6.53	250
LJ9-F(c)	120	170	4.9	1.7	0.66	41	153	5.69	8.55	150
LJ9-F(d)	83	170	4.2	1.1	0.63	44	85	6.28	9.89	280
LJ9J(a)	92	160	4.5	1.7	0.67	45	130	6.37	9.44	200
LJ9J(b)	110	150	4.7	1.5	1.00	43	134	6.03	9.14	210
LJ9J(c	93	150	3.9	1.9	0.71	52	134	5.57	7.86	180
LJ9J(d)	89	140	4.5	5.9	0.79	85	146	6.83	8.62	100
LJ9J(e)	99	88	3.9	4.2	0.76	66	136	6.02	7.97	110
LJ9K(a)	130	190	5.0	2.3	0.73	57	143	5.30	7.25	170
LJ9K(b)	110	180	4.1	1.4	0.68	47	115	4.78	7.06	210
LJ9K(c)	200	170	7.3	1.5	0.70	53	103	5.54	7.94	190
LJ9K(d)	240	210	7.7	2.2	0.74	62	131	4.96	6.68	140
LJ9-D(a)	8.7	24	0.4	8.1	0.80	73	282	4.82	6.02	-
LJ9-D(b)	9.1	24	0.3	4.9	0.77	61	249	3.70	4.84	-
LJ9-D(c)	8.3	23	0.4	8.6	0.81	80	250	4.87	6.01	-
LJ9-D(d)	7.6	18	0.2	3.8	0.76	61	187	3.52	4.65	-
LJ9-G(a)	11	37	0.4	2.1	0.76	67	151	3.60	4.75	180
LJ9-G(b)	7.6	28	0.3	1.4	0.65	46	97	4.29	6.56	140
LJ9-G(c)*	8.5	28	0.9	2.2	0.74	70	114	10.4	13.9	180
LJ9-G(d)	10	30	0.3	1.4	0.64	40	129	3.20	4.96	170
LJ9-E(a)#	31	71	1.0	2.2	0.69	43	225	3.82	5.55	-
LJ9-E(b)#	31	38	3.5	1.3	0.66	41	140	16.2	24.5	-
LJ9-E(c)#	17	28	0.5	1.7	0.67	41	193	3.80	5.64	-
LJ9-E(e)#	16	37	8.0	0.2	0.68	41	195	60.3	89.1	18
LJ9-E(g)#	10	33	0.2	2.3	0.69	50	128	2.03	2.94	130
LJ9-E(h)#	53	68	6.1	2.4	0.69	45	166	16.4	23.7	96

LJ9-E(i)#	39	53	3.8	2.3	0.69	45	155	13.7	19.8	89
JS1-D(a)	4.2	14	0.7	2.6	0.69	45	183	16.1	23.2	160
JS1-D(b)	3.4	12	0.5	1.7	0.65	41	142	13.7	20.7	180
JS1-D(c)*	3.1	10	2.6	2.0	0.68	48	116	83.0	121	160
JS1-D(e)	2.7	8.3	0.4	1.6	0.65	40	139	13.5	20.5	140
JS1-E(a)	3.7	12	0.5	3.3	0.71	48	196	12.6	17.7	140
JS1-E(b)	3.0	10	0.5	3.6	0.73	56	158	17.7	24.2	140
JS1-E(c)	4.3	14	0.6	2.6	0.70	50	141	15.2	21.6	140
JS1-E(d)	3.8	12	0.5	2.3	0.68	46	151	12.4	17.9	110
JS1-E(e)	2.9	9	0.3	3.0	0.71	53	149	9.56	13.3	110
JS1-3(a)*	18	27	4.2	2.4	0.72	54	139	31.9	44.4	8
JS1-3(b)	3.1	18	0.3	1.3	0.62	40	114	8.16	12.9	120
JS1-3(d)*	59	110	20.4	2.0	0.68	42	198	44.6	65.2	240
JS1-3(e)	3.0	20	0.3	1.3	0.65	44	124	6.18	9.36	130
JS1-3(f)	15	25	0.7	1.0	0.66	49	92	6.26	9.42	27
MC-6(a)	15	32	0.6	3.9	0.75	57	223	5.00	6.63	58
MC-6(b)	22	34	0.9	4.2	0.76	57	240	5.57	7.34	54
MC-6(i)	21	36	0.7	1.9	0.675	40	223	4.54	6.71	35
MC-8(a)	12	28	0.8	12.1	0.82	80	351	7.67	9.23	140
MC-8(b)	7.5	22	0.5	4.7	0.74	51	334	7.31	9.77	76
MC-8(c)	8.3	27	0.4	2.9	0.707	46	257	5.40	7.59	56
MC-8(d)	13	26	0.8	3.2	0.742	57	180	8.03	10.8	50
MC-8(e)	15	39	0.9	3.2	0.728	51	223	7.17	9.80	80
MC-8(f)	8.4	22	0.5	3.4	0.732	51	240	6.21	8.43	66
MC-8(g)	11	25	0.7	5.6	0.779	66	240	7.26	9.24	110
MC-8(h)	5.1	19	0.5	4.1	0.749	57	231	9.81	12.9	100
MC-8(i)	7.9	23	0.5	4.1	0.718	46	369	6.22	8.55	99
MC-8(j)	8.3	26	0.5	2.5	0.702	46	223	6.82	9.66	54
MC-8(k)**	11	25	0.3	4.5	0.756	57	257	3.74	4.87	200
MC-8(l)	7.8	21	0.7	6.2	0.777	63	291	10.2	12.9	160
MC-8(m)	8.3	23	0.6	5.1	0.765	60	266	8.08	10.4	170
regional samples										
X10(a)#	5.5	1.4	0.2	2.7	0.71	44	259	5.79	8.11	-
X10(c)#	4.0	1.4	0.6	1.8	0.69	41	202	26.5	38.7	-
X10(e)#	18	15	1.5	1.2	0.67	42	150	12.5	18.5	240
LJ2-E(a)	160	120	59.1	2.7	0.72	44	324	56.8	79.0	220
LJ2-E(c)*	97	81	69.6	2.9	0.75	49	387	109	145	93
LJ2-E(d)	180	120	58.5	2.2	0.70	42	283	55.5	78.8	240
LJ2-E(e)	150	97	42.3	1.8	0.70	42	260	44.1	63.1	300
H3-C(a)	37	3.2	17.1	2.3	0.72	49	177	83.3	115	-
H3-C(b)	18	1.0	5.1	2.9	0.75	55	181	50.5	67.6	-

H3-C(d)	22	1.1	10.5	9.9	0.83	84	263	87.3	105	-
JZ4(b)	6.9	3.2	4.6	1.6	0.68	41	177	110	162	-
JZ4(c)	9.9	2.3	5.0	2.5	0.71	45	228	87.7	123	-
MC-9(a)	35	45	40.4	5.6	0.77	60	291	162	205	510
MC-9(b)	28	24	40.0	2.9	0.73	51	206	216	290	160
MC-9(c)	22	18	20.2	3.4	0.73	49	266	140	187	240
MC-9(d)	16	12	13.1	3.8	0.75	54	240	128	168	170
MC-9(e)	19	15	16.6	4.2	0.76	57	240	136	175	240
MC-9(f)	25	16	20.6	2.5	0.71	46	223	131	181	160
MC-9(g)	15	16	16.3	7.6	0.80	74	257	156	186	490
MC-9(h)	24	18	19.3	5.5	0.75	51	386	126	166	54
MC-9(i)	30	27	25.1	4.0	0.74	51	283	126	168	47
MC-9(j)	22	16	16.6	2.6	0.71	46	231	118	164	23

Notes:

* Anomalously old age. Replicate age is >45% older than the mean of the other three or more replicates and shows excess helium compared to other replicates with similar U and Th values. This is most likely due to undissolved inclusions of more retentive phases or helium implantation from neighboring phases. Age excluded from calculation of mean age and standard deviation

\# Replicates display poor reproducibility with standard deviation >65%.
No mean age reported.

** Anomalously young age. Replicate age is >50% younger than the mean of the other twelve replicates and shows insufficient helium compared to other replicates with similar U and Th values. This may be due to partial degassing. Age excluded from the calculation of the mean age and standard deviation.

\#\# Ft is alpha-ejection correction after Farley et al. (1996)

Table DR3. Summary of the apatite fission-track age data I - ICPMS data

Sample	Grains	Dpar (μm)	Dper (μm)	Ns (tracks)	Area Analyzed (cm^2)	rho_s (cm^{-2})	$\Sigma(P\Omega)$ (cm^2)	+/- 1σ $\Sigma(P\Omega)$ (cm^2)	ξ_{MS}	+/−1σ ξ_{MS}	^{43}Ca bkg:sig (dmnls)	^{238}U bkg:sig (dmnls)	Q (dmnls)	Pooled Fission-Track Age +/- 1σ (Ma)	Central Age (Ma)
Laji Shan															
LJ8-C	24	1.82	0.5	622	9.99E-04	6.23E+05	1.30E-04	2.36E-06	15.5221	0.3938	3.50E-02	3.58E-02	0	37.1 +/- 1.9	37.8
LJ8-D	25	1.88	0.51	1000	1.07E-03	9.35E+05	1.08E-04	1.80E-06	15.2978	0.3937	5.91E-02	8.58E-02	0	70.5 +/- 3.1	75.2
LJ8-G	25	1.58	0.35	384	1.07E-03	3.59E+05	5.49E-05	1.06E-06	15.0735	0.3936	3.52E-02	6.49E-02	0.291	52.5 +/- 3.2	52.5
LJ8-H	25	1.69	0.42	648	1.17E-03	5.54E+05	7.41E-05	1.31E-06	14.8493	0.3935	3.20E-02	3.52E-02	0.001	64.6 +/- 3.3	64.6
LJ8-I	25	1.62	0.37	972	5.70E-04	1.71E+06	1.23E-04	2.77E-06	14.625	0.3934	3.01E-02	1.79E-02	0	57.6 +/- 2.7	58.9
Jishi Shan															
LJ9-A	23	2.29	0.75	980	6.17E-04	1.59E+06	3.06E-04	5.32E-06	14.4007	0.3933	3.88E-02	3.24E-02	0.001	23.0 +/- 1.0	23.4
LJ9-C	16	1.69	0.41	140	6.35E-04	2.20E+05	7.11E-05	1.67E-06	14.2168	0.3932	3.30E-02	5.49E-03	0.564	14.0 +/- 1.3	13.4
LJ9-D	25	2.02	0.58	136	1.21E-03	1.12E+05	5.26E-05	9.75E-07	14.0329	0.3931	3.69E-02	3.99E-02	0.675	18.1 +/- 1.7	16.2
LJ9-G	25	1.98	0.63	127	1.05E-03	1.21E+05	4.78E-05	8.83E-07	13.8087	0.393	3.64E-02	5.56E-01	0.166	18.3 +/- 1.7	18.2
LJ9-K	25	2.95	0.96	1151	1.03E-03	1.12E+06	3.55E-04	2.05E-06	10.9264	0.2144	5.24E-02	9.51E-02	0	17.7 +/- 0.6	18.1

Abbreviations

Ns	number of spontaneous tracks
rho_s	spontaneous track density
Dpar	diameter of etch pit parallel to crystallographic c-axis
Dper	diameter of etch pit perpendicular to crystallographic c-axis
$\Sigma(P\Omega)$	sum of $^{238}U/^{43}Ca$ (P) and counting area (Ω)
ξ_{MS}	calibration factor based on LA-ICP-MS of fission track age standards
Q	χ2 test result, expressed as a per cent, with 5% passing the χ2 test

see Donelick et al., 2005 for full description

Table DR4. Summary of the apatite fission-track length data I - ICPMS samples

Sample	Tracks	mean length (μm)	standard deviation (μm)	Dpar (μm)	Dper (μm)
Laji Shan					
LJ8-C	129	14.34	1.21	1.82	0.50
LJ8-D	135	14.01	1.40	1.88	0.51
LJ8-G	131	14.11	1.36	1.58	0.35
LJ8-H	132	14.23	1.51	1.69	0.42
LJ8-I	125	14.20	1.04	1.62	0.37
Jishi Shan					
LJ9-A	125	14.27	1.60	2.29	0.75
LJ9-C	54	14.34	1.07	1.69	0.41
LJ9-D	131	14.42	1.22	2.02	0.58
LJ9-G	93	14.79	1.26	1.98	0.63
LJ9-K	129	14.35	1.19	2.95	0.96

Abbreviations

Dpar diameter of etch pit parallel to crystallographic c-axis

Dper diameter of etch pit perpendicular to crystallographic c-axis

see Donelick et al., 2005 for full description

all track lengths projected onto the crystallographic c-axis (Ketcham et al., 2007)

Table DR5. Summary of apatite fission track data II - EDM data

Sample	Grains	rho_s ($10^6 cm^{-2}$)	N_s	rho_i ($10^6 cm^{-2}$)	N_i	$P(x^2)$	rho_D ($10^6 cm^{-2}$)	N_D	Age±1σ (Ma)	ML±1σ (μm)	SD_{ML} (μm)	N_F	Cl^- (wt %)	SD_{Cl} (wt %)	N_{Cl}
Laji Shan															
MC-8	30	0.313	706	1.66	3742	12	1.191	3452	34.1±3.7	11.1±0.6	3.26	18	0.01	0.02	10
Z-4	24	0.581	1096	2.68	5044	12	1.049	2623	39.8±2	9.9±0.7	2.66	40	0.02	0.01	10
Z-5	24	0.441	650	2.26	3337	13	1.058	2645	36.0±1.8	9.7±0.5	2.48	82	0.05	0.03	10
Z-7	27	0.334	491	2.8	4122	10	1.067	2667	22.2±1.2	10.9±0.6	3.6	43	0.08	0.02	10
MC-6	27	0.19	459	2.38	5762	10	1.075	2689	15.0±0.8	10.1±0.5	4.07	30	0.01	0.02	10

Abbreviations

rho_s	spontaneous fission track density
N_s	number of spontaneous fission tracks counted
rho_i	induced fission track density
N_i	number of induced fission tracks counted
$P(x^2)$	probability of obtained X2 value of v degrees of freedom (where v is number of crystal-1)
rho_D	induced fission track density of dosimeter glass SRM612
N_D	number of induced fission tracks of dosimeter glass SRM612
ML	mean confined fission track length
SD_{ML}	standard deviation of track length
N_F	number of confined tracks
Cl^-	Chlorine content
SD_{Cl}	standard deviation of chlorine content
N_{Cl}	number of chlorine measurements

see Wang et al., 2003 for full description

track lengths not projected onto the crystallographic c-axis