GSA Data Repository Item:

(A) Data tables:

Table 1. Composition of N White Mountains apatite

sample	elev.	unit	n	F	±	Cl	±
	m			wt%	wt%	wt%	wt%
95BR053	2220	Kbp	10	2.53	0.19	0.01	0.01
95BR056	2230	Kpg	10	2.66	0.17	0.01	0.01
95BR067	2070	Kbp	10	2.59	0.22	0.01	0.01
95BR068	2060	Kbp	10	2.71	0.24	0.01	0.01
96BR201	2280	Kbp	10	3.62	0.63	0.00	0.00
96BR210	3020	Kpg	10	2.68	0.22	0.01	0.01
96BR211	3460	Kpg	10	2.59	0.22	0.01	0.01
96BR212	3680	Kpg	10	2.66	0.15	0.01	0.01
96BR213	4110	Kpg	10	2.69	0.25	0.01	0.01
96BR214B	3780	Kpg	10	2.61	0.22	0.02	0.01
96BR215	3340	Kpg	10	2.49	0.21	0.01	0.01
96BR216	3030	Kbp	10	2.45	0.12	0.01	0.01
96BR217	2750	Kbp	10	n/a	n/a	n/a	n/a
96BR218	2380	Kbp	10	2.88	0.30	0.00	0.00
97WM068	2010	Kpg	10	3.01	0.38	0.01	0.01

Electron microprobe results of composition analyses of apatites from the northern White Mountains. For analytical procedures see appendix B. Units are Kbp = Cretaceous Boundary Peak pluton and Kpg = Cretaceous Pellisier Flat pluton. Analytical procedures are described in Appendix B.

Table 2. Apatite fission track data from the northern White Mountains

sample	lat./long.	PD (km)	# Xls	ρd	(Nd)	ρs	(Ns)	ρi	(Ni)	U ppm	AFT age (Ma)±1σ	P(X^2) %	mean track length (μm)±1σ(n)
95BR053	37°50'04"/118°24'37"	6.60	40	1.754	5185	0.037	90	1.000	2454	7.1	12.1 ± 1.5	7	13.65 ± 0.27 (26)
95BR056	37°53'42"/118°22'43"	6.55	30	1.769	5185	0.286	416	6.872	9980	48.6	14.2 ± 1.0	1	11.72± 0.21 (150)
95BR067	37°46'56"/118°24'36"	6.50	40	1.754	5185	0.037	90	1.000	2454	7.1	12.1 ± 1.5	54	13.90 ± 0.32 (45)
95BR068	37°46'05"/118°23'50"	6.25	40	1.754	5185	0.037	90	1.000	2454	7.1	12.1 ± 1.5	69	14.20 ± 0.24 (33)
96BR201	37°49'11"/118°14'24"	0.01	40	1.622	4901	0.030	37	1.263	1542	9.7	6.9 ± 1.2	86	13.89 ± 0.19 (30)
96BR210	37°47'50"/118°17'47"	1.65	25	1.713	5246	0.509	310	2.602	1586	19.0	59.3 ± 3.8	97	13.31 ± 0.12 (120)
96BR211	37°47'32"/118°18'08"	2.10	25	1.731	5246	0.291	224	1.528	1175	11.0	57.5 ± 5.1	71	13.23 ± 0.21 (100)
96BR212	37°47'16"/118°19'10"	2.25	25	1.731	5246	0.291	224	1.528	1175	21.2	58.6 ± 4.5	56	13.14 ± 0.18 (79)
96BR213	37°46'45"/118°19'50"	2.27	25	1.731	5246	0.319	281	1.708	1504	24.3	53.5 ± 3.2	47	12.86 ± 0.14 (100)
96BR214-B	37°47'19"/118°21'50"	3.65	25	1.758	5246	0.615	420	3.970	2713	28.2	51.6 ± 2.8	14	12.38 ± 0.16 (120)
96BR215	37°47'00"/118°22'00"	4.25	25	1.758	5246	0.315	193	2.965	1819	21.1	43.3 ± 2.7	32	11.45 ± 0.17 (120)
96BR216	37°46'47"/118°22'56"	5.00	25	1.776	5246	0.260	155	2.346	1398	16.5	35.0 ± 3.0	100	10.31 ± 0.22 (90)
96BR217	37°46'50"/118°23'13"	5.50	25	1.776	5246	0.110	111	1.333	1350	9.4	25.9 ± 2.6	100	10.73 ± 0.21 (120)
96BR218	37°46'51"/118°24'20"	5.70	25	1.795	5246	0.053	76	1.232	1774	8.6	13.7 ± 1.6	99	12.57 ± 0.18 (120)
97WM068	37°59'30"/118°22'20"	6.50	40	1.754	5185	0.037	90	1.000	2454	7.1	12.1 ± 1.5	54	13.90 ± 0.32 (45)

Apatite fission track data from the northern White Mountains. Abbreviations are lat., latitude; long., longitude; PD, sample paleodepth (km); # Xls, number of individual grains dated; ρd, induced track density in external detector adjacent to dosimetry glass(x 10^6 tracks per square centimeter); Nd, number of tracks counted in determining ρ-d; ρs, spontaneous track density (x 10^6 tracks per square centimeter); Ns, number of spontaneous tracks counted; ρi, induced track density in external detector (muscovite) (x 10^6 tracks per square centimeter); Ni, number of induced tracks counted; U, Uranium concentration in ppm; P(X^2), X^2 probability (Galbraith, 1981; Green, 1981). Age is the sample central fission track age (Galbraith and Laslett, 1993) calculated using zeta calibration method (Hurford and Green, 1983).

The following is a summary of key laboratory procedures. Samples were analyzed by D. Stockli (zeta factor of 356±5). All apatites were etched for 20 s in 5N nitric acid at room temperature. Grains were dated by external detector method with muscovite detectors. The CN5 dosimetry glass was used as a neutron flux monitor. Samples were irradiated in well thermalized positions at the Oregon State University TRIGA reactor. External detectors were etched in 48% HF. Tracks were counted with Zeiss Axioskop microscope with 100x air objective, 1.25x tube factor, 10x eyepieces, transmitted light with supplementary reflected light as needed; external detector prints were located with Kinetek automated scanning stage (Dumitru, 1993). Only grains with c axes subparallel to slide plane were dated. Confined tracks lengths were measured only in grains with c axes subparallel to slide plane; only horizontal tracks measured (within ±~5-10°), following protocols of Laslett et al. (1982). Lengths were measured with computer digitizing tablet and drawing tube, calibrated against stage micrometer (e.g., Dumitru, 1993).

Table 3. Apatite (U-Th)/He data from the northern White Mountains

sample	elev. m	PD km	He nmol/g	U ppm	Th ppm	Ft	Corrected age (Ma)	±1σ Ma
95BR053	2220	6.60	0.22	9.3	8.7	0.75	4.8	0.6
95BR056	2230	6.55	0.61	25.4	15.4	0.73	5.3	0.3
95BR067.1	2070	6.50	0.13	4.7	9.5	0.76	4.5	0.9
95BR067.2	2070	6.50	0.16	5.1	8.3	0.76	5.5	0.5
97BR067	2070	6.42	0.31	4.7	8.1	0.70	12.2	1.9
95BR068.1	2060	6.25	0.21	3.5	6.0	0.79	10.2	0.9
95BR068.2	2060	6.25	0.31	5.5	10.3	0.71	9.6	0.8
96BR201.1	2280	0.01	0.61	9.7	18.6	0.72	11.1	0.8
96BR201.2	2280	0.01	0.33	5.2	10.2	0.70	11.6	1.4
96BR210	3020	1.65	5.25	10.2	47.2	0.68	57.5	0.9
96BR211	3460	2.10	3.98	10.5	39.3	0.68	54.8	1.1
96BR213	4110	2.27	4.77	13.4	43.7	0.69	53.8	1.1
96BR214-A	3980	3.35	3.87	20.1	38.6	0.66	37.1	0.9
96BR214-B	3780	3.65	2.66	16.0	40.6	0.72	26.8	0.6
96BR215.1	3340	4.25	1.45	13.3	24.8	0.70	20.0	0.5
96BR215.2	3340	4.25	1.23	12.0	25.8	0.73	17.3	0.6
96BR216.1	3030	5.00	0.84	8.8	17.5	0.78	12.2	0.7
96BR216.2	3030	5.00	0.58	8.4	16.7	0.66	13.2	1.5
96BR217.1†	2750	5.5	2.94	5.2	12.5	0.72	92.8	2.0
96BR217.2†	2750	5.5	1.81	4.3	11.7	0.74	63.6	1.2
96BR217.3†	2750	5.5	1.31	4.7	12.3	0.71	45.2	1.8
96BR218.1	2380	5.7	0.33	5.0	10.1	0.75	11.0	0.9
96BR218.2	2380	5.7	0.39	5.8	9.8	0.74	12.1	1.1
97WM068	2010	6.50	0.92	11.9	42.5	0.69	11.3	0.6

Elev. = sample elevation, Ft = Alpha ejection correction after Farley et al. (1996). All analyses with detected excess He from U and Th bearing inclusions are not reported and are excluded from interpretation. Analyses characterized by anomalously old ages attributed to parentless He or excess He from fluid inclusions (†) are not included in Figure 3. The dimensions of the apatite grains in each sample (10-20 grains) were measured to determine the alpha-emission correction (Farley et al., 1996). He ages were calculated based on absolute He and U-Th determinations on the same sample. For helium analyses, samples were first outgassed (Wolf et al., 1996), then retrieved and dissolved in a doubly spiked (^{230}Th-^{235}U) HNO_3 solution in preparation for U and Th determinations using isotope dilution ICP-MS. Analyses were performed by D. Stockli at the California Institute of Technology in the laboratory of K. A. Farley.

(B) Analytical procedures

He and U-Th determinations

All He determinations were carried out at the Noble Gas Laboratory at Caltech using an isotope dilution (^{3}He spike) quadrupole mass spectrometry system. He was extracted from ~10 to 20 grains of hand-picked, inclusion-free apatite separates in a single-walled vacuum furnace for 20 minutes at ~950°C. Furnace blanks were routinely measured yielding typical values on the order of ~1 femtomol of He. Subsequent to gettering and cryogenic purification (cycling between 16 and 34 K), the extracted He was analyzed with a Balzers Prisma quadrupole mass-spectrometer using isotope dilution with ~5 femtomol of 99.5% ^{3}He. The amount of spike was determined to better than 1% and the precision on He determinations is better than 1% with blanks. Grains were then retrieved, dissolved in nitric acid and spiked with isotopically enriched U and Th. U and Th concentrations are determined by isotope dilution inductively coupled plasma mass spectrometry (ICP-MS) using a Finnigan Element. Similar uncertainties apply to the ICP-MS U and Th determinations. Thus the analytical uncertainties on age determinations are generally better than 6% (±2-σ).

Electron microprobe analysis

The compositions of all apatite samples from the northern White Mountains were analyzed following the protocol of Stormer et al. (1993) for Cl, F, Ca, and P using a JEOL JXA-733A superprobe electron microprobe. Ten grains were selected per sample and each analyzed in three different spots at ~7 keV with a defocused beam. All determination were performed on polished sections parallel to the apatite c-axis to minimize X-ray intensity variations due to anisotropy in apatite. Durango apatite was also analyzed as an unknown to test the accuracy of the F and Cl determinations.

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