

Public-data File 90-7a

**PRELIMINARY RESULTS OF 11 APATITE FISSION-TRACK ANALYSES OF  
SAMPLES FROM THE GALBRAITH LAKE-TOOLIK LAKE REGION,  
NORTH SLOPE, ALASKA**

by

Paul B. O'Sullivan

Department of Geology  
La Trobe University  
Bundoora, Victoria 3083  
Australia

and

Alaska Division of  
Geological and Geophysical Surveys

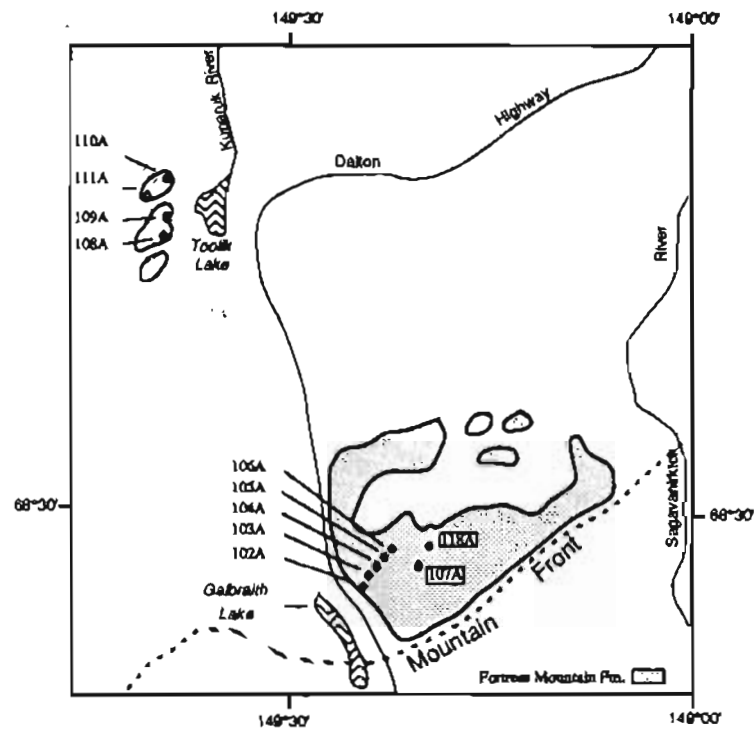
January 1990

THIS REPORT HAS NOT BEEN REVIEWED FOR  
TECHNICAL CONTENT (EXCEPT AS NOTED IN  
TEXT) OR FOR CONFORMITY TO THE  
EDITORIAL STANDARDS OF DGGs.

794 University Avenue, Suite 200  
Fairbanks, Alaska 99709-3645

## CONTENTS

	<u>Page</u>
Contents and Location Map	2
Introduction	3
Sample Information and Track Length Data	4
Data From Fortress Mountain	5
Data From Toolik Lake	12
Confined Track Length Distributions	16



**Figure 1:** Map showing approximate locations of samples collected for this study.

## INTRODUCTION

This is a preliminary report of apatite fission track analysis data of samples from the Fortress Mountain and Toolik Lake region of the North Slope of Alaska. During 1989, samples were collected along a vertical traverse up Fortress Mountain and along a section directly west of Toolik Lake. Apatite grains were separated from the samples and analyzed in Melbourne Australia at the La Trobe University Fission Track Research Laboratory. Separations and grain-mounts were completed by Geotrack International. All analyses were completed by the author as part of an ongoing PhD project funded in part by the U.S. Minerals Management Service Continental Margins Program.

Each analysis includes two parts: 1) age report; and 2) track length distributions. The age report shows a listing of the individual grain ages, the resulting age and pertinent information used in determining the age. A guide to read the information is as follows:

<u>POS 22A-Tuaktu Fm.</u>	-Sample number and unit collected
Irradiation:	-In-house number for grouping samples from the same irradiation package
Crystal	-Number of each grain counted
NS	-Number of spontaneous tracks counted
NI	-Number of induced tracks counted
NA	-Number of area units counted in grain
Ratio	-Ratio of (NS/NI) for each grain
U(ppm)	-Uranium concentration of each grain
RHOs	-Density of spontaneous tracks (per cm <sup>2</sup> )
RHOi	-Density of induced tracks (per cm <sup>2</sup> )
F.T.Age(Ma)	-Individual grain ages
CHI Squared	-Statistical test for determining multiple grain populations
p(chi squared)	-probability of less than 5% indicates multiple grain populations
Variance of SQR	-Statistical comparison of values of NS or NI for all grains
NS/NI	-Pooled ratio of (NS/NI). Uses total number of spontaneous and induced tracks counted for whole sample. Value used in age calculation if sample is of a single population
Mean Ratio	-Average ratio of (NS/NI) for grains
Pooled Age	-Age calculated using NS/NI(single population)
Mean Age	-Age calculated Using "Mean Ratio" (multiple populations)

The track length distributions for each sample are histograms showing the relative numbers of tracks measured at a particular length, the mean length of the tracks measured, the standard deviation of the tracks measured, and the total number of tracks measured for the sample (N).

## SAMPLE INFORMATION

Fission track ages are typically determined on 20 grains of apatite from a single sample and 100 confined tracks are typically measured for each track length distribution. All samples from Fortress Mountain yielded apatite in adequate amounts for 20 individual grains to be dated while two of four samples from Toolik Lake did not produce 20 dateable grains. Most samples from both areas yielded grains representing multiple populations so the mean age is presented (shown by a \* in table below). For the few for which it was determined that the dated grains represented a single population, the pooled age is presented. Due to young apparent ages, low uranium concentrations, and low yields in some samples, only three samples yielded >100 confined tracks.

Sample No.	Formation	Elevation (ft)	Lengths (#)	Mean Length ( $\mu\text{m}$ )	Age (Ma)
<i>FORTRESS MTN.</i>					
89 POS 102A	Fortress Mtn.	3100	102	13.94	67.1*
89 POS 103A	Fortress Mtn.	3430	106	13.21	61.2
89 POS 104A	Fortress Mtn.	3740	56	13.63	44.3*
89 POS 105A	Fortress Mtn.	4130	22	13.98	52.8*
89 POS 106A	Fortress Mtn.	4530	100	13.72	52.9*
89 POS 107A	Fortress Mtn.	4690	71	13.12	56.7
89 POS 118A	Fortress Mtn.	4460	44	14.23	57.0*
<i>TOOLIK LAKE</i>					
89 POS 108A	Fortress Mtn.	2700	29	12.31	61.8*
89 POS 109A	Fortress Mtn.	2600	33	13.93	50.9*
89 POS 110A	Fortress Mtn.	2730	38	14.04	72.8*
89 POS 111A	Fortress Mtn.	2520	61	14.01	51.0*

## TRACK LENGTH DATA

Sample Number	Track Length Range ( $\mu\text{m}$ )													
	<5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	>17
<i>FORTRESS MTN.</i>														
102A	0	0	0	1	1	1	1	8	17	17	26	21	7	2
103A	3	0	0	0	4	4	7	7	13	17	31	14	4	2
104A	1	0	0	0	0	1	1	4	8	14	15	8	4	0
105A	0	0	0	0	0	0	1	1	4	6	3	5	2	0
106A	0	1	1	0	1	2	4	7	13	18	25	23	5	0
107A	0	0	0	3	4	4	2	3	4	16	28	6	1	0
118A	0	0	0	1	0	2	2	1	1	7	12	12	6	0
<i>TOOLIK LAKE</i>														
108A	1	1	0	0	0	0	3	6	6	6	4	1	1	0
109A	0	0	0	0	0	0	0	1	10	7	7	6	2	0
110A	0	0	0	0	0	0	0	5	7	5	8	10	3	0
111A	1	0	0	0	1	0	1	2	7	14	17	11	7	0

## DATA FROM FORTRESS MOUNTAIN

89POS102A APATITE Fortress Mtn. Fm.

IRRADIATION GT067

SLIDE NUMBER 5

COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	14	32	60	0.438	6.0	2.655E+05	6.068E+05	102.1 ± 32.8
2	10	26	28	0.385	10.4	4.064E+05	1.057E+06	89.9 ± 33.5
3	1	12	42	0.083	3.2	2.709E+04	3.251E+05	19.6 ± 20.4
4	20	99	42	0.202	26.3	5.418E+05	2.682E+06	47.4 ± 11.7
5	24	168	36	0.143	52.1	7.585E+05	5.310E+06	33.5 ± 7.4
6	3	7	70	0.429	1.1	4.876E+04	1.138E+05	100.0 ± 69.1
7	1	8	60	0.125	1.5	1.896E+04	1.517E+05	29.3 ± 31.1
8	4	14	60	0.286	2.6	7.585E+04	2.655E+05	66.9 ± 37.9
9	16	90	20	0.178	50.3	9.102E+05	5.120E+06	41.7 ± 11.4
10	5	13	35	0.385	4.2	1.625E+05	4.226E+05	89.9 ± 47.3
11	18	34	56	0.500	7.2	3.657E+05	7.314E+05	123.4 ± 36.0
12	9	17	60	0.529	3.2	1.707E+05	3.224E+05	123.4 ± 50.9
13	4	15	36	0.267	4.7	1.264E+05	4.741E+05	62.4 ± 35.2
14	11	26	80	0.423	3.6	1.564E+05	3.698E+05	98.8 ± 35.6
15	3	19	50	0.158	4.2	6.827E+04	4.324E+05	37.0 ± 23.0
16	7	20	49	0.350	4.6	1.625E+05	4.644E+05	81.8 ± 36.0
17	2	18	49	0.111	4.1	4.644E+04	4.180E+05	26.1 ± 19.5
18	0	12	64	0.000	2.1	0.000E+00	2.133E+05	0.0 ± 0.0
19	5	14	50	0.357	3.1	1.138E+05	3.186E+05	83.5 ± 43.5
20	8	16	50	0.500	3.6	1.820E+05	3.641E+05	116.6 ± 50.6
21	3	21	30	0.143	7.8	1.138E+05	7.964E+05	33.5 ± 20.7
	168	681			7.4	1.861E+05	7.567E+05	

Area of basic unit = 8.789E-07 cm-2

CHI SQUARED = 38.022 WITH 20 DEGREES OF FREEDOM

P(chi squared) = 0.9 %

CORRELATION COEFFICIENT = 0.836

VARIANCE OF SQR(Ns) = 1.61

VARIANCE OF SQR(Ni) = 6.69

Ns/Ni = 0.246 ± 0.021

MEAN RATIO = 0.285 ± 0.034

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass

RHO D = 1.334E+06cm-2; ND = 2098

POOLED AGE = 57.8 ± 5.1 Ma

MEAN AGE = 67.1 ± 8.3 Ma

89POS103A APATITE Fortress Mtn. Fm.

IRRADIATION GT067

SLIDE NUMBER 6

COUNTED BY: POS

No.	Ns	Ni	Na	RATIO U (ppm)	RHOs	RHOi	F.T. AGE (Ma)	
1	43	177	42	0.243	47.1	1.165E+06	4.795E+06	56.9 ± 9.8
2	4	9	30	0.444	3.4	1.517E+05	3.413E+05	103.7 ± 62.4
3	6	12	36	0.500	3.7	1.896E+05	3.793E+05	116.6 ± 58.4
4	3	10	20	0.300	5.6	1.707E+05	5.689E+05	70.2 ± 46.2
5	3	7	35	0.429	2.2	9.752E+04	2.276E+05	100.0 ± 69.1
6	4	14	56	0.286	2.8	8.127E+04	2.844E+05	66.9 ± 37.9
7	4	11	30	0.364	4.1	1.517E+05	4.172E+05	85.0 ± 49.7
8	2	17	25	0.118	7.6	9.102E+04	7.737E+05	27.6 ± 20.7
9	2	16	35	0.125	5.1	6.502E+04	5.201E+05	29.3 ± 22.0
10	3	14	42	0.214	3.7	8.127E+04	3.793E+05	50.2 ± 32.0
11	5	17	30	0.294	6.3	1.896E+05	6.447E+05	68.8 ± 35.1
12	0	6	30	0.000	2.2	0.000E+00	2.276E+05	0.0 ± 0.0
13	1	5	30	0.200	1.9	3.793E+04	1.896E+05	46.9 ± 51.4
14	0	7	24	0.000	3.3	0.000E+00	3.319E+05	0.0 ± 0.0
15	3	6	35	0.500	1.9	9.752E+04	1.950E+05	116.6 ± 82.5
16	13	51	48	0.255	11.9	3.082E+05	1.209E+06	59.7 ± 18.6
17	1	19	40	0.053	5.3	2.844E+04	5.404E+05	12.4 ± 12.7
18	8	31	49	0.258	7.1	1.858E+05	7.198E+05	60.4 ± 24.0
19	0	10	30	0.000	3.7	0.000E+00	3.793E+05	0.0 ± 0.0
20	13	16	35	0.812	5.1	4.226E+05	5.201E+05	188.4 ± 70.5
	118	455			7.2	1.913E+05	7.375E+05	

Area of basic unit = 8.789E-07 cm<sup>2</sup>

CHI SQUARED = 26.341 WITH 19 DEGREES OF FREEDOM

P(chi squared) = 12.1 %

CORRELATION COEFFICIENT = 0.960

VARIANCE OF SQR(Ns) = 2.20

VARIANCE OF SQR(Ni) = 5.98

Ns/Ni = 0.259 ± 0.027

MEAN RATIO = 0.270 ± 0.045

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass

RHO D = 1.334E+06cm<sup>-2</sup>; ND = 2098

POOLED AGE = 60.7 ± 6.4 Ma

MEAN AGE = 63.1 ± 10.8 Ma

89POS104A APATITE Fortress Mtn. Fm.

IRRADIATION GT067

SLIDE NUMBER 7

COUNTED BY: POS

No.	Ns	Ni	Na	RATIO U (ppm)		RHOs	RHOi	F.T. AGE (Ma)
1	20	72	80	0.278	10.1	2.844E+05	1.024E+06	65.0 ± 16.5
2	20	108	30	0.185	40.2	7.585E+05	4.096E+06	43.4 ± 10.6
3	6	39	64	0.154	6.8	1.067E+05	6.933E+05	36.1 ± 15.9
4	16	50	25	0.320	22.3	7.282E+05	2.276E+06	74.8 ± 21.6
5	26	114	42	0.228	30.3	7.043E+05	3.088E+06	53.4 ± 11.7
6	37	178	30	0.208	66.3	1.403E+06	6.751E+06	48.7 ± 8.9
7	12	58	30	0.207	21.6	4.551E+05	2.200E+06	48.5 ± 15.4
8	0	18	36	0.000	5.6	0.000E+00	5.689E+05	0.0 ± 0.0
9	17	75	28	0.227	29.9	6.908E+05	3.048E+06	53.1 ± 14.3
10	3	13	36	0.231	4.0	9.482E+04	4.109E+05	54.1 ± 34.7
11	29	137	56	0.212	27.3	5.892E+05	2.784E+06	49.6 ± 10.2
12	12	48	70	0.250	7.7	1.950E+05	7.802E+05	58.5 ± 18.9
13	16	73	40	0.219	20.4	4.551E+05	2.076E+06	51.4 ± 14.2
14	3	21	48	0.143	4.9	7.111E+04	4.978E+05	33.5 ± 20.7
15	3	31	24	0.097	14.4	1.422E+05	1.470E+06	22.7 ± 13.8
16	4	16	70	0.250	2.6	6.502E+04	2.601E+05	58.5 ± 32.8
17	133	336	60	0.396	62.6	2.522E+06	6.372E+06	92.5 ± 9.7
18	3	19	42	0.158	5.1	8.127E+04	5.147E+05	37.0 ± 23.0
19	28	189	35	0.148	60.3	9.102E+05	6.144E+06	34.8 ± 7.1
20	9	74	28	0.122	29.5	3.657E+05	3.007E+06	28.5 ± 10.1
21	0	5	28	0.000	2.0	0.000E+00	2.032E+05	0.0 ± 0.0
22	1	8	70	0.125	1.3	1.625E+04	1.300E+05	29.3 ± 31.1
	398	1682			19.3	4.659E+05	1.969E+06	

Area of basic unit = 8.789E-07 cm<sup>2</sup>

CHI SQUARED = 48.862 WITH 21 DEGREES OF FREEDOM

P(chi squared) = 0.1 %

CORRELATION COEFFICIENT = 0.927

VARIANCE OF SQR(Ns) = 6.20

VARIANCE OF SQR(Ni) = 16.23

Ns/Ni = 0.237 ± 0.013

MEAN RATIO = 0.189 ± 0.020

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass

RHO D = 1.334E+06cm<sup>-2</sup>; ND = 2098

POOLED AGE = 55.4 ± 3.4 Ma

MEAN AGE = 44.3 ± 4.7 Ma

89POS105A APATTITE Fortress Mtn. Fm.

IRRADIATION GT067  
SLIDE NUMBER 8  
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	11	15	0.000	8.2	0.000E+00	8.344E+05	0.0 ± 0.0
2	9	28	63	0.321	5.0	1.625E+05	5.057E+05	75.2 ± 28.9
3	26	109	64	0.239	19.0	4.622E+05	1.938E+06	55.9 ± 12.3
4	29	114	20	0.254	63.7	1.650E+06	6.485E+06	59.6 ± 12.5
5	9	29	100	0.310	3.2	1.024E+05	3.300E+05	72.6 ± 27.8
6	40	207	25	0.193	92.5	1.820E+06	9.421E+06	45.3 ± 7.9
7	15	62	42	0.242	16.5	4.064E+05	1.680E+06	56.7 ± 16.4
8	29	132	20	0.220	73.7	1.650E+06	7.509E+06	51.5 ± 10.6
9	9	16	40	0.562	4.5	2.560E+05	4.551E+05	131.0 ± 54.7
10	1	23	49	0.043	5.2	2.322E+04	5.341E+05	10.2 ± 10.4
11	4	37	20	0.108	20.7	2.276E+05	2.105E+06	25.4 ± 13.4
12	1	5	12	0.200	4.7	9.482E+04	4.741E+05	46.9 ± 51.4
13	8	29	28	0.276	11.6	3.251E+05	1.178E+06	64.6 ± 25.8
14	36	58	28	0.621	23.1	1.463E+06	2.357E+06	144.4 ± 30.8
15	0	3	20	0.000	1.7	0.000E+00	1.707E+05	0.0 ± 0.0
16	24	115	48	0.209	26.8	5.689E+05	2.726E+06	48.9 ± 11.0
17	43	323	35	0.133	103.1	1.398E+06	1.050E+07	31.2 ± 5.1
18	2	9	30	0.222	3.4	7.585E+04	3.413E+05	52.1 ± 40.7
19	2	9	25	0.222	4.0	9.102E+04	4.096E+05	52.1 ± 40.7
20	1	7	32	0.143	2.4	3.556E+04	2.489E+05	33.5 ± 35.8
21	41	191	60	0.215	35.6	7.775E+05	3.622E+06	50.3 ± 8.7
	329	1517			21.8	4.824E+05	2.224E+06	

Area of basic unit = 8.789E-07 cm<sup>2</sup>

CHI SQUARED = 53.575 WITH 20 DEGREES OF FREEDOM

P(chi squared) = 0.0 %

CORRELATION COEFFICIENT = 0.888

VARIANCE OF SQR(Ns) = 4.92

VARIANCE OF SQR(Ni) = 20.93

Ns/Ni = 0.217 ± 0.013

MEAN RATIO = 0.225 ± 0.033

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass

RHO D = 1.334E+06cm<sup>-2</sup>; ND = 2098

POOLED AGE = 50.8 ± 3.3 Ma

MEAN AGE = 52.8 ± 7.8 Ma



89POS106A APATITE Fortress Mtn. Fm.

IRRADIATION GT067  
SLIDE NUMBER 9  
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	20	64	40	0.312	17.9	5.689E+05	1.820E+06	73.1 ± 18.8
2	5	69	42	0.072	18.4	1.354E+05	1.869E+06	17.0 ± 7.9
3	2	6	36	0.333	1.9	6.321E+04	1.896E+05	77.9 ± 63.7
4	33	180	30	0.183	67.0	1.252E+06	6.827E+06	43.0 ± 8.2
5	27	149	32	0.181	52.0	9.600E+05	5.298E+06	42.5 ± 8.9
6	22	153	50	0.144	34.2	5.006E+05	3.482E+06	33.7 ± 7.7
7	21	115	64	0.183	20.1	3.733E+05	2.044E+06	42.8 ± 10.2
8	8	19	40	0.421	5.3	2.276E+05	5.404E+05	98.3 ± 41.5
9	34	256	30	0.133	95.3	1.289E+06	9.709E+06	31.2 ± 5.7
10	8	36	36	0.222	11.2	2.528E+05	1.138E+06	52.1 ± 20.4
11	1	4	36	0.250	1.2	3.161E+04	1.264E+05	58.5 ± 65.5
12	41	262	40	0.156	73.2	1.166E+06	7.452E+06	36.7 ± 6.2
13	20	53	21	0.377	28.2	1.084E+06	2.872E+06	88.2 ± 23.2
14	13	94	70	0.138	15.0	2.113E+05	1.528E+06	32.5 ± 9.6
15	5	26	80	0.192	3.6	7.111E+04	3.698E+05	45.1 ± 22.0
16	8	33	36	0.242	10.2	2.528E+05	1.043E+06	56.8 ± 22.4
17	24	156	40	0.154	43.6	6.827E+05	4.437E+06	36.1 ± 8.0
18	3	23	60	0.130	4.3	5.689E+04	4.362E+05	30.6 ± 18.8
19	0	1	36	0.000	0.3	0.000E+00	3.161E+04	0.0 ± 0.0
20	9	13	24	0.692	6.1	4.267E+05	6.163E+05	160.8 ± 69.9
	304	1712			22.7	4.103E+05	2.311E+06	

Area of basic unit = 8.789E-07 cm<sup>2</sup>

CHI SQUARED = 40.880 WITH 19 DEGREES OF FREEDOM

P(chi squared) = 0.2 %

CORRELATION COEFFICIENT = 0.937

VARIANCE OF SQR(Ns) = 3.11

VARIANCE OF SQR(Ni) = 21.27

Ns/Ni = 0.178 ± 0.011

MEAN RATIO = 0.226 ± 0.033

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass

RHO D = 1.334E+06cm<sup>-2</sup>; ND = 2098

POOLED AGE = 41.6 ± 2.8 Ma

MEAN AGE = 52.9 ± 7.9 Ma

89POS107 APATITE Fortress Mtn. Fm.

IRRADIATION GT067

SLIDE NUMBER 10

COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	30	94	40	0.319	26.3	8.533E+05	2.674E+06	74.6 ± 15.8
2	4	12	60	0.333	2.2	7.585E+04	2.276E+05	77.9 ± 45.0
3	9	25	42	0.360	6.6	2.438E+05	6.773E+05	84.1 ± 32.8
4	60	196	48	0.306	45.6	1.422E+06	4.646E+06	71.6 ± 10.7
5	8	37	16	0.216	25.8	5.689E+05	2.631E+06	50.7 ± 19.8
6	19	42	25	0.452	18.8	8.647E+05	1.911E+06	105.6 ± 29.3
7	10	33	25	0.303	14.7	4.551E+05	1.502E+06	70.9 ± 25.6
8	1	11	80	0.091	1.5	1.422E+04	1.564E+05	21.4 ± 22.3
9	88	386	40	0.228	107.8	2.503E+06	1.098E+07	53.4 ± 6.4
10	18	78	24	0.231	36.3	8.533E+05	3.698E+06	54.1 ± 14.2
11	4	16	30	0.250	6.0	1.517E+05	6.068E+05	58.5 ± 32.8
12	13	57	35	0.228	18.2	4.226E+05	1.853E+06	53.4 ± 16.5
13	16	119	28	0.134	47.5	6.502E+05	4.836E+06	31.6 ± 8.4
14	5	10	42	0.500	2.7	1.354E+05	2.709E+05	116.6 ± 63.9
15	29	115	80	0.252	16.1	4.124E+05	1.636E+06	59.1 ± 12.4
16	11	74	40	0.149	20.7	3.129E+05	2.105E+06	34.9 ± 11.3
17	39	194	40	0.201	54.2	1.109E+06	5.518E+06	47.1 ± 8.3
18	2	15	20	0.133	8.4	1.138E+05	8.533E+05	31.3 ± 23.6
19	2	9	60	0.222	1.7	3.793E+04	1.707E+05	52.1 ± 40.7
20	11	42	70	0.262	6.7	1.788E+05	6.827E+05	61.3 ± 20.8
	379	1565			20.7	5.103E+05	2.107E+06	

Area of basic unit = 8.789E-07 cm<sup>2</sup>

CHI SQUARED = 23.741 WITH 19 DEGREES OF FREEDOM

P(chi squared) = 20.6 %

CORRELATION COEFFICIENT = 0.967

VARIANCE OF SQR(Ns) = 4.70

VARIANCE OF SQR(Ni) = 19.56

Ns/Ni = 0.242 ± 0.014

MEAN RATIO = 0.259 ± 0.023

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass

RHO D = 1.334E+06cm<sup>-2</sup>; ND = 2098

POOLED AGE = 56.7 ± 3.5 Ma

MEAN AGE = 60.5 ± 5.6 Ma

89POS118A APATITE Fortress Mtn. Fm.

IRRADIATION GT071

SLIDE NUMBER 2

COUNTED BY: POS

No.	Ns	Ni	Na	RATIO U (ppm)		RHOs	RHOi	F.T. AGE (Ma)
1	30	129	48	0.233	31.1	7.111E+05	3.058E+06	52.7 ± 10.8
2	12	52	36	0.231	16.7	3.793E+05	1.643E+06	52.3 ± 16.8
3	19	85	70	0.224	14.0	3.088E+05	1.382E+06	50.7 ± 12.9
4	33	155	49	0.213	36.5	7.663E+05	3.599E+06	48.3 ± 9.3
5	4	15	90	0.267	1.9	5.057E+04	1.896E+05	60.4 ± 34.0
6	54	200	56	0.270	41.3	1.097E+06	4.064E+06	61.1 ± 9.5
7	88	366	30	0.240	141.0	3.338E+06	1.388E+07	54.5 ± 6.6
8	1	6	70	0.167	1.0	1.625E+04	9.752E+04	37.8 ± 40.8
9	7	42	60	0.167	8.1	1.327E+05	7.964E+05	37.8 ± 15.5
10	8	41	100	0.195	4.7	9.102E+04	4.665E+05	44.2 ± 17.1
11	13	100	80	0.130	14.4	1.849E+05	1.422E+06	29.5 ± 8.7
12	7	19	42	0.368	5.2	1.896E+05	5.147E+05	83.3 ± 36.9
13	70	117	50	0.598	27.0	1.593E+06	2.662E+06	134.7 ± 20.6
14	18	54	42	0.333	14.9	4.876E+05	1.463E+06	75.4 ± 20.6
15	29	105	60	0.276	20.2	5.499E+05	1.991E+06	62.5 ± 13.2
16	20	150	64	0.133	27.1	3.556E+05	2.667E+06	30.3 ± 7.2
17	13	49	9	0.265	62.9	1.643E+06	6.195E+06	60.1 ± 18.8
18	11	44	28	0.250	18.2	4.470E+05	1.788E+06	56.6 ± 19.1
19	66	234	28	0.282	96.6	2.682E+06	9.509E+06	63.8 ± 9.0
20	3	16	80	0.188	2.3	4.267E+04	2.276E+05	42.5 ± 26.8
	506	1979			20.9	5.272E+05	2.062E+06	

Area of basic unit = 8.789E-07 cm<sup>2</sup>

CHI SQUARED = 53.047 WITH 19 DEGREES OF FREEDOM

P(chi squared) = 0.0 %

CORRELATION COEFFICIENT = 0.898

VARIANCE OF SQR(Ns) = 5.44

VARIANCE OF SQR(Ni) = 18.26

Ns/Ni = 0.256 ± 0.013

MEAN RATIO = 0.251 ± 0.023

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass

RHO D = 1.290E+06cm<sup>-2</sup>; ND = 2030

POOLED AGE = 57.9 ± 3.2 Ma

MEAN AGE = 57.0 ± 5.3 Ma

## DATA FROM TOOLIK LAKE

89POS108A APATITE Fortress Mtn. Fm.

IRRADIATION GT067  
SLIDE NUMBER 11  
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	7	45	25	0.156	20.1	3.186E+05	2.048E+06	36.5 ± 14.9
2	3	11	54	0.273	2.3	6.321E+04	2.318E+05	63.8 ± 41.6
3	12	86	28	0.140	34.3	4.876E+05	3.495E+06	32.7 ± 10.1
4	0	7	24	0.000	3.3	0.000E+00	3.319E+05	0.0 ± 0.0
5	21	72	20	0.292	40.2	1.195E+06	4.096E+06	68.3 ± 17.0
6	55	361	25	0.152	161.3	2.503E+06	1.643E+07	35.7 ± 5.2
7	21	24	25	0.875	10.7	9.557E+05	1.092E+06	202.6 ± 60.7
8	6	64	30	0.094	23.8	2.276E+05	2.427E+06	22.0 ± 9.4
9	5	27	70	0.185	4.3	8.127E+04	4.389E+05	43.4 ± 21.2
10	4	13	24	0.308	6.1	1.896E+05	6.163E+05	72.0 ± 41.2
11	15	96	16	0.156	67.0	1.067E+06	6.827E+06	36.7 ± 10.2
12	57	264	60	0.216	49.2	1.081E+06	5.006E+06	50.6 ± 7.5
13	6	26	20	0.231	14.5	3.413E+05	1.479E+06	54.1 ± 24.5
14	4	20	15	0.200	14.9	3.034E+05	1.517E+06	46.9 ± 25.7
15	9	79	15	0.114	58.8	6.827E+05	5.992E+06	26.7 ± 9.4
16	132	119	70	1.109	19.0	2.146E+06	1.934E+06	255.8 ± 32.9
17	16	56	30	0.286	20.9	6.068E+05	2.124E+06	66.9 ± 19.0
18	4	50	30	0.080	18.6	1.517E+05	1.896E+06	18.8 ± 9.8
19	23	73	36	0.315	22.7	7.269E+05	2.307E+06	73.7 ± 17.7
20	12	124	25	0.097	55.4	5.461E+05	5.643E+06	22.7 ± 6.9
	412	1617			28.1	7.302E+05	2.866E+06	

Area of basic unit = 8.789E-07 cm<sup>2</sup>

CHI SQUARED = 235.725 WITH 19 DEGREES OF FREEDOM

P(chi squared) = 0.0 %

CORRELATION COEFFICIENT = 0.548

VARIANCE OF SQR(Ns) = 6.59

VARIANCE OF SQR(Ni) = 17.08

Ns/Ni = 0.255 ± 0.014

MEAN RATIO = 0.264 ± 0.059

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass

RHO D = 1.334E+06cm<sup>-2</sup>; ND = 2098

POOLED AGE = 59.7 ± 3.6 Ma

MEAN AGE = 61.8 ± 14.0 Ma

89POS109A APATITE Fortress Mtn. Fm.

IRRADIATION GT067

SLIDE NUMBER 12

COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	2	16	36	0.125	5.0	6.321E+04	5.057E+05	29.3 ± 22.0
2	39	238	50	0.164	53.2	8.875E+05	5.416E+06	38.4 ± 6.7
3	0	5	16	0.000	3.5	0.000E+00	3.556E+05	0.0 ± 0.0
4	4	22	20	0.182	12.3	2.276E+05	1.252E+06	42.6 ± 23.2
5	25	160	28	0.156	63.8	1.016E+06	6.502E+06	36.7 ± 7.9
6	10	89	32	0.112	31.1	3.556E+05	3.164E+06	26.4 ± 8.8
7	97	75	60	1.293	14.0	1.839E+06	1.422E+06	297.3 ± 46.3
8	0	2	40	0.000	0.6	0.000E+00	5.689E+04	0.0 ± 0.0
9	0	20	25	0.000	8.9	0.000E+00	9.102E+05	0.0 ± 0.0
10	7	17	40	0.412	4.7	1.991E+05	4.836E+05	96.1 ± 43.2
11	1	3	60	0.333	0.6	1.896E+04	5.689E+04	77.9 ± 90.0
12	4	17	45	0.235	4.2	1.011E+05	4.298E+05	55.1 ± 30.7
13	9	72	30	0.125	26.8	3.413E+05	2.731E+06	29.3 ± 10.4
14	12	98	35	0.122	31.3	3.901E+05	3.186E+06	28.7 ± 8.8
15	0	1	15	0.000	0.7	0.000E+00	7.585E+04	0.0 ± 0.0
210		835			17.5	4.491E+05	1.786E+06	

Area of basic unit = 8.789E-07 cm<sup>-2</sup>

CHI SQUARED = 178.001 WITH 14 DEGREES OF FREEDOM

P(chi squared) = 0.0 %

CORRELATION COEFFICIENT = 0.488

VARIANCE OF SQR(Ns) = 7.46

VARIANCE OF SQR(Ni) = 19.03

Ns/Ni = 0.251 ± 0.019

MEAN RATIO = 0.217 ± 0.083

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass

RHO D = 1.334E+06cm<sup>-2</sup>; ND = 2098

POOLED AGE = 58.9 ± 4.8 Ma

MEAN AGE = 50.9 ± 19.5 Ma

89POS110A APATTTE Fortress Mtn. Fm.

IRRADIATION GT067

SLIDE NUMBER 13

COUNTED BY: POS

No.	Ns	Ni	Na	RATIO U (ppm)		RHOs	RHOi	F.T. AGE (Ma)
1	7	24	30	0.292	8.9	2.655E+05	9.102E+05	68.3 ± 29.4
2	43	106	25	0.406	47.4	1.957E+06	4.824E+06	94.7 ± 17.3
3	2	14	16	0.143	9.8	1.422E+05	9.956E+05	33.5 ± 25.4
4	11	43	15	0.256	32.0	8.344E+05	3.262E+06	59.9 ± 20.3
5	10	27	16	0.370	18.9	7.111E+05	1.920E+06	86.5 ± 32.1
6	19	57	16	0.333	39.8	1.351E+06	4.053E+06	77.9 ± 20.7
7	11	9	32	1.222	3.1	3.911E+05	3.200E+05	281.3 ± 126.6
8	2	17	28	0.118	6.8	8.127E+04	6.908E+05	27.6 ± 20.7
9	51	318	56	0.160	63.4	1.036E+06	6.461E+06	37.6 ± 5.7
10	0	21	20	0.000	11.7	0.000E+00	1.195E+06	0.0 ± 0.0
11	15	19	18	0.789	11.8	9.482E+05	1.201E+06	183.1 ± 63.4
12	63	417	30	0.151	155.3	2.389E+06	1.582E+07	35.4 ± 4.9
13	4	17	24	0.235	7.9	1.896E+05	8.059E+05	55.1 ± 30.7
14	0	2	15	0.000	1.5	0.000E+00	1.517E+05	0.0 ± 0.0
15	7	16	8	0.438	22.3	9.956E+05	2.276E+06	102.1 ± 46.3
16	11	42	15	0.262	31.3	8.344E+05	3.186E+06	61.3 ± 20.8
17	10	87	16	0.115	60.8	7.111E+05	6.187E+06	27.0 ± 9.0
	266	1236			36.3	7.964E+05	3.701E+06	

Area of basic unit = 8.789E-07 cm<sup>2</sup>

CHI SQUARED = 77.042 WITH 16 DEGREES OF FREEDOM

P(chi squared) = 0.0 %

CORRELATION COEFFICIENT = 0.920

VARIANCE OF SQR(Ns) = 4.99

VARIANCE OF SQR(Ni) = 26.14

Ns/Ni = 0.215 ± 0.015

MEAN RATIO = 0.311 ± 0.073

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass

RHO D = 1.334E+06cm<sup>-2</sup>; ND = 2098

POOLED AGE = 50.4 ± 3.6 Ma

MEAN AGE = 72.8 ± 17.1 Ma

89POS111A APATITE Fortress Mtn. Fm.

IRRADIATION GT071

SLIDE NUMBER 1

COUNTED BY: POS

No.	Ns	Ni	Na	RATIO U (ppm)		RHOs	RHOi	F.T. AGE (Ma)
1	3	24	90	0.125	3.1	3.793E+04	3.034E+05	28.4 ± 17.4
2	11	140	80	0.079	20.2	1.564E+05	1.991E+06	17.8 ± 5.6
3	11	74	48	0.149	17.8	2.607E+05	1.754E+06	33.7 ± 10.9
4	29	151	35	0.192	49.8	9.427E+05	4.909E+06	43.5 ± 8.9
5	46	283	70	0.163	46.7	7.477E+05	4.600E+06	36.9 ± 5.9
6	10	57	36	0.175	18.3	3.161E+05	1.801E+06	39.8 ± 13.7
7	6	17	70	0.353	2.8	9.752E+04	2.763E+05	79.8 ± 37.9
8	10	27	64	0.370	4.9	1.778E+05	4.800E+05	83.7 ± 31.1
9	4	14	50	0.286	3.2	9.102E+04	3.186E+05	64.7 ± 36.7
10	2	8	35	0.250	2.6	6.502E+04	2.601E+05	56.6 ± 44.8
11	46	316	30	0.146	121.7	1.745E+06	1.198E+07	33.0 ± 5.3
12	11	73	56	0.151	15.1	2.235E+05	1.483E+06	34.2 ± 11.1
13	19	44	63	0.432	8.1	3.431E+05	7.946E+05	97.5 ± 26.9
14	3	6	50	0.500	1.4	6.827E+04	1.365E+05	112.8 ± 79.8
15	5	72	70	0.069	11.9	8.127E+04	1.170E+06	15.8 ± 7.3
16	3	21	35	0.143	6.9	9.752E+04	6.827E+05	32.4 ± 20.0
17	5	28	70	0.179	4.6	8.127E+04	4.551E+05	40.5 ± 19.7
18	12	65	42	0.185	17.9	3.251E+05	1.761E+06	41.9 ± 13.2
19	3	14	36	0.214	4.5	9.482E+04	4.425E+05	48.6 ± 30.9
20	24	71	50	0.338	16.4	5.461E+05	1.616E+06	76.4 ± 18.1
	263	1505			16.1	2.771E+05	1.586E+06	

Area of basic unit = 8.789E-07 cm-2

CHI SQUARED = 43.628 WITH 19 DEGREES OF FREEDOM

P(chi squared) = 0.1 %

CORRELATION COEFFICIENT = 0.922

VARIANCE OF SQR(Ns) = 2.65

VARIANCE OF SQR(Ni) = 18.51

Ns/Ni = 0.175 ± 0.012

MEAN RATIO = 0.225 ± 0.026

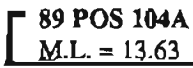
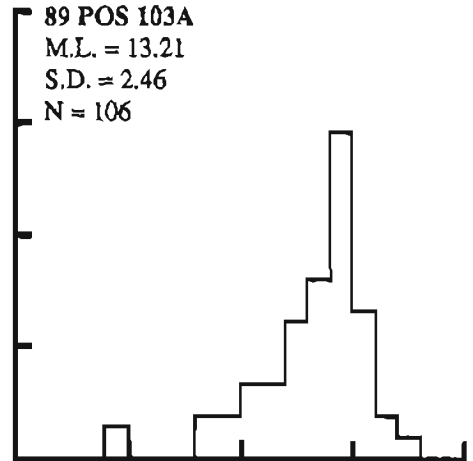
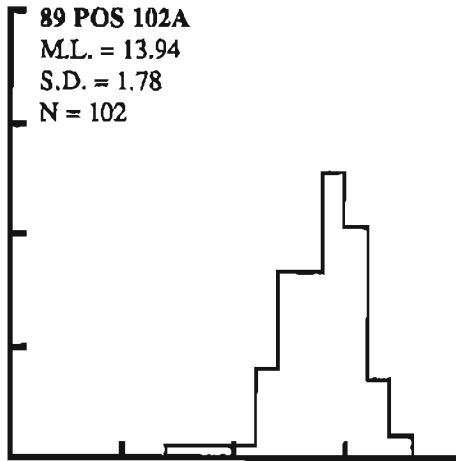
Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass

RHO D = 1.290E+06cm-2; ND = 2030

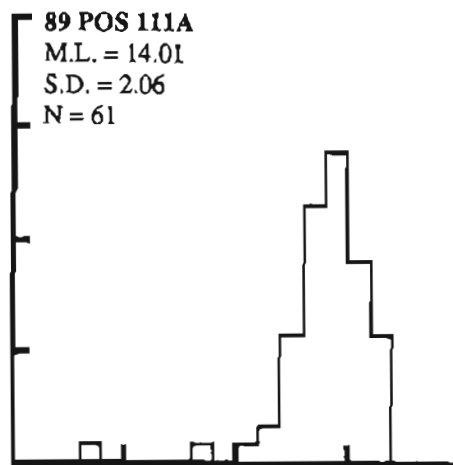
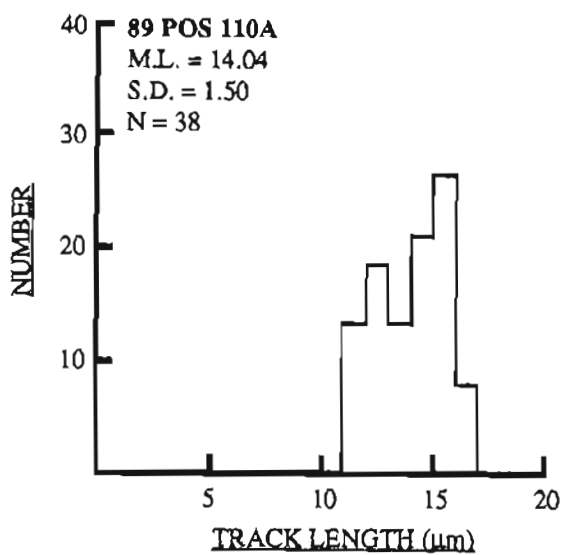
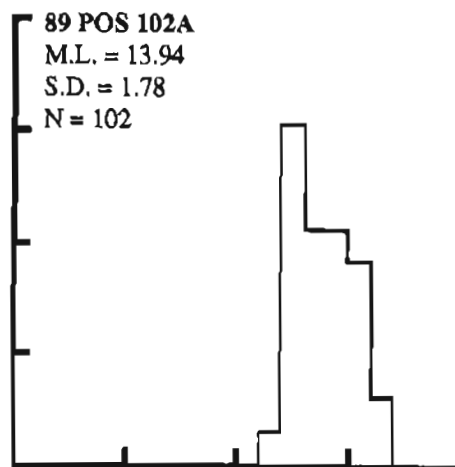
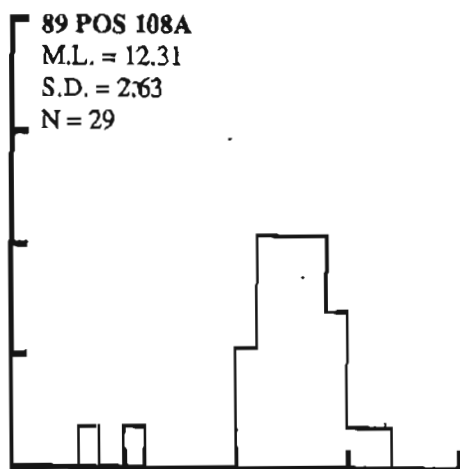
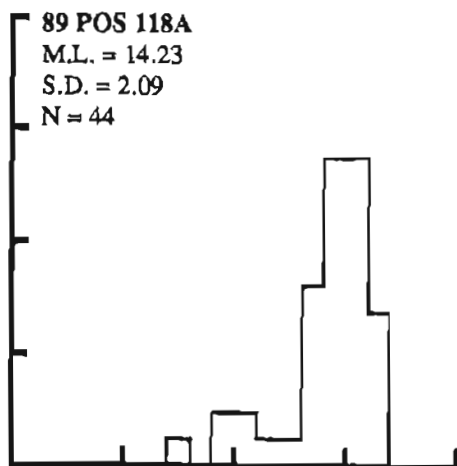
POOLED AGE = 39.6 ± 2.8 Ma

MEAN AGE = 51.0 ± 6.1 Ma

TRACK LENGTH DATA







**TRACK LENGTH ( $\mu\text{m}$ )**