Public-data File 91-14

RESULTS OF NINE APATITE FISSION TRACK ANALYSES OF SAMPLES COLLECTED FROM THE BIG FISH RIVER AREA, NORTHERN YUKON TERRITORY, CANADA

by

Paul B. O'Sullivan

Department of Geology
LaTrobe University
Bundoora, Victoria 3083
Australia

and

Alaska Division of
Geological and Geophysical Surveys

April 1991

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

CONTENTS

LOCALITY MAP

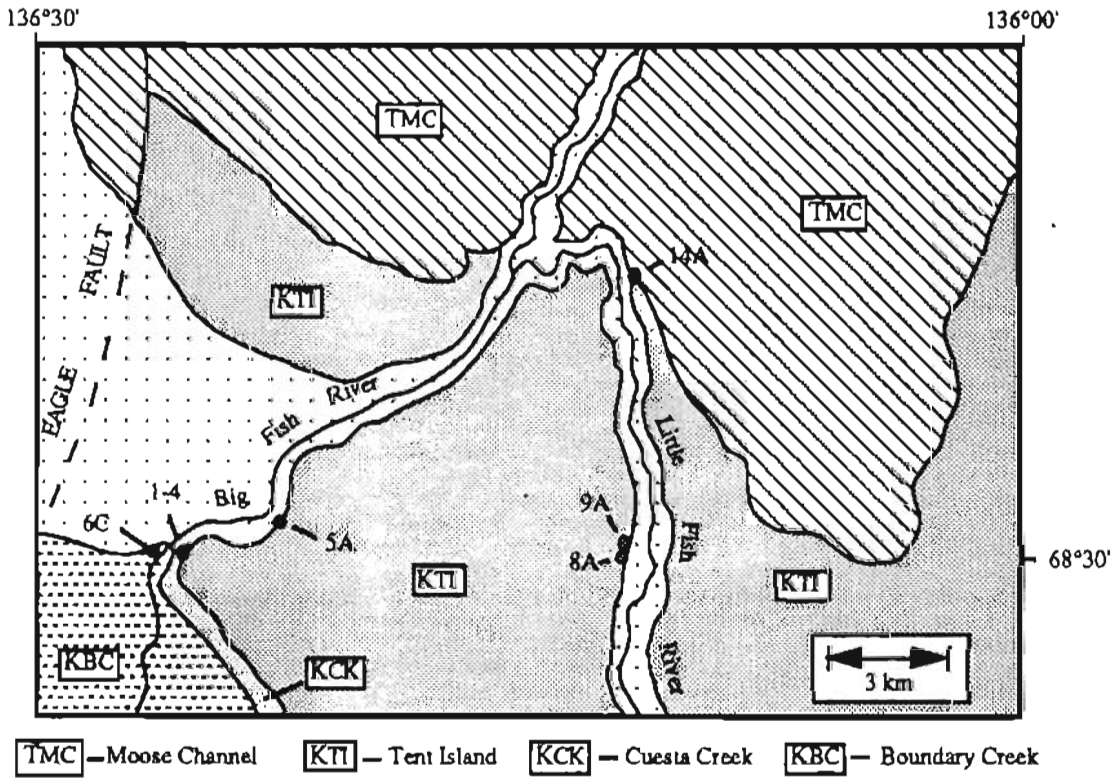


Figure 1. Regional map showing localities from which the nine samples analyzed for this study were collected. Moving up-section, sample 6C is from the Cretaceous Boundary Creek Formation. Samples 1A, 2B, 3A, and 4A are from a section of the Cuesta Creek Member of the Cretaceous Tent Island Formation. Samples 5A, 8A, and 9A are all from further up-section in the Tent Island Formation. Sample 14A is from the overlying Tertiary Moose Channel Formation.

INTRODUCTION

This is a preliminary report of apatite fission track analyses of samples from a stratigraphic section along the Big Fish and Little Fish Rivers' in the foothills region north of the Brooks Range in the Yukon Territory. Apatite grains were separated from 9 samples and analyzed in Melbourne Australia at the La Trobe University Fission Track Research Laboratory. Separations, grain-mounts, and all analyses were completed by the author .

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:

88 POS 01A	-Sample number and information
IRRADIATION	-In-house number for grouping samples from the same irradiation package
SLIDE NUMBER	-Number of individual mount from irradiation package
No	-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 (ppm)
RHOs	-Density of spontaneous tracks (per cm^2)
RHOi	-Density of induced tracks (per cm^2)
F.T.AGE (Ma)	-Individual fission track 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).

TECHNIQUES

Apatites and zircons were separated from samples by conventional heavy liquid and magnetic techniques. The mineral separates were mounted in epoxy resin on glass slides, ground and polished to expose internal surfaces of the grains, then etched to reveal the fossil fission tracks. Neutron irradiations were carried out in a well thermalized flux in the Australian Atomic Energy Commissions HIFAR reactor. Thermal neutron fluences were monitored by counting tracks recorded in muscovite detectors attached to pieces of the NBS standard glass SRM612. Fission tracks in each mount were counted in transmitted light using a dry 80x objective at a total magnification of 1250x. Wherever possible, tracks were counted over 20 grains in each mount for apatite and 10 for zircons. For further description, the methodology used for fission track counting has been described in detail by Moore et al. (1986) and Green (1986).

Analyses were carried out by the author in the laboratories of the La Trobe University Fission Track Research Laboratory, Melbourne, Australia. Ages were calculated using the standard fission track age equation using the zeta calibration method (Hurford and Green, 1982) and errors were calculated using the techniques outlined by Green (1981). In samples with a significant spread in single grain ages, the "conventional analysis", (as defined by Green 1981), based purely on Poissonian variation, is not valid. In such cases, which can be detected by a Chi squared statistic (Galbraith, 1981), the mean age provides a useful measure (Green, 1981). The Chi squared statistic indicates the probability that all grains counted belong to a single population of ages. A probability of less than 5% is taken as evidence of a significant spread of single grain ages. A spread in individual grain ages can result either from inheritance of detrital grains from mixed source areas, or from differential annealing in grains of different composition by heating within a narrow range of temperatures (Green et al. 1989).

Lengths of confined tracks (Lal et al. 1969), in apatite only, were measured using the procedure outlined by Green (1986) and Green (1989). Only fully etched and horizontal "confined tracks" were measured (Laslett et al. 1982), in grains with polished surfaces parallel to prismatic crystal faces. Measurements were made under similar conditions to those employed for age determination. The lengths of suitable tracks were measured using a

projection tube and a Hipad™ digitizing tablet calibrated using a stage micrometer (with μm divisions). As many tracks as possible (up to 100) were measured from each sample. The number of confined tracks measured for each sample are shown in Table 1. In most cases less than 100 tracks were recorded due to a scarcity of apatite grains, low U concentration, and/or young ages for the samples. The number of tracks per each μm division for each track length distribution is shown in Table 2.

SAMPLE RESULTS

For the purpose of this report, fission track ages were determined using 20 individual grain ages (if possible) from each sample and as many confined track length measurements up to ~100. Though typical yields for the samples were poor, in most cases 20 dateable grains were found on each mount. Due to relatively young ages and low uranium content, only 2 mounts contained 100 or more confined tracks and an additional 1 mount had between 50 and 100 tracks. Two mounts had less than 20 confined tracks. A few samples yielded grains representing multiple populations so the mean age is presented (shown by a * in table below). For those which it was determined that the dated grains could represent a single population, the pooled age is presented.

Table 1. Sample results

Sample No.	Unit	Lengths (#)	Mean Len. (μm)	Age (Ma ± 1σ)
88 POS 01A	Cuesta Creek Mem.	31	12.51	50.0 ± 4.7
88 POS 02B	Cuesta Creek Mem.	31	13.61	53.9 ± 10.4
88 POS 03A	Cuesta Creek Mem.	5	11.88	55.7 ± 3.3
88 POS 04A	Cuesta Creek Mem.	11	14.04	47.3 ± 5.1
88 POS 05A	Tent Island Fm.	103	13.36	60.3 ± 7.2*
88 POS 06C	Boundary Creek Fm.	102	14.22	53.7 ± 4.5
88 POS 08A	Tent Island Fm.	32	12.91	86.9 ± 5.1
88 POS 09A	Tent Island Fm.	30	13.18	107.1 ± 15.5
88 POS 14A	Moose Channel Fm.	81	13.25	95.0 ± 18.2*

Table 2. Track length data

Sample Number	Track Length Range (μm)													
	<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
01A	0	0	0	0	0	1	2	4	4	10	8	2	0	0
02B	0	0	0	0	0	3	1	0	5	7	9	5	1	0
03A	1	0	0	0	0	0	0	0	1	1	1	1	0	0
04A	0	0	0	0	0	0	0	1	2	2	4	2	0	0
05A	0	0	1	0	0	1	8	16	11	22	26	15	3	0
06C	0	1	0	0	0	0	2	3	11	15	38	27	3	2
08A	0	0	0	2	0	0	1	7	6	8	4	3	1	0
09A	0	0	0	0	0	2	2	3	5	9	7	2	0	0
14A	1	1	0	0	2	4	5	5	10	19	19	11	4	0

When the data is plotted with respect to relative position within the stratigraphic section (Fig. 2) the apatite ages fall into a well-defined pattern. Apatite ages older than ~55 Ma and from the upper part of the Tent Island Formation and the Moose Channel Formation define a shallow slope in the age vrs. section plot. Ages younger than ~55 Ma and from lower in the section in the Cuesta Creek Member of the Tent Island Formation and from the Boundary Creek Formation do not change significantly down section and define a much steeper slope. A "break in slope" is evident in the apatite age-stratigraphic section pattern here at ~55 Ma.

PRELIMINARY INTERPRETATIONS

The apatite fission track data has delineated a two-component uplift history for the region of the Big Fish River. The "break in slope" at ~55 Ma (Fig. 2) marks the base of an uplifted annealing zone and represents the time of initiation of uplift of the Big Fish River section. The shallow gradient defined by ages older than 55 Ma is an inherited characteristic from the pre-uplift apatite annealing zone. Ages younger than 55 Ma defining the steeper part of the apatite age profile are "uplift" ages, that is, they were recorded after uplift began. Prior to this, they lay below the base of the annealing zone at temperatures too high to record tracks. Therefore, following deposition, heating associated with burial resulted in the samples from above the Cuesta Creek Member being exposed to elevated temperatures in the range ~70-100°C while samples from the underlying Cuesta Creek Member and Boundary Creek Formation being

exposed to temperatures needed to totally anneal previously existing tracks (>~110°C). Subsequently, the entire section was uplifted at ~55 Ma as recorded by the lower section.

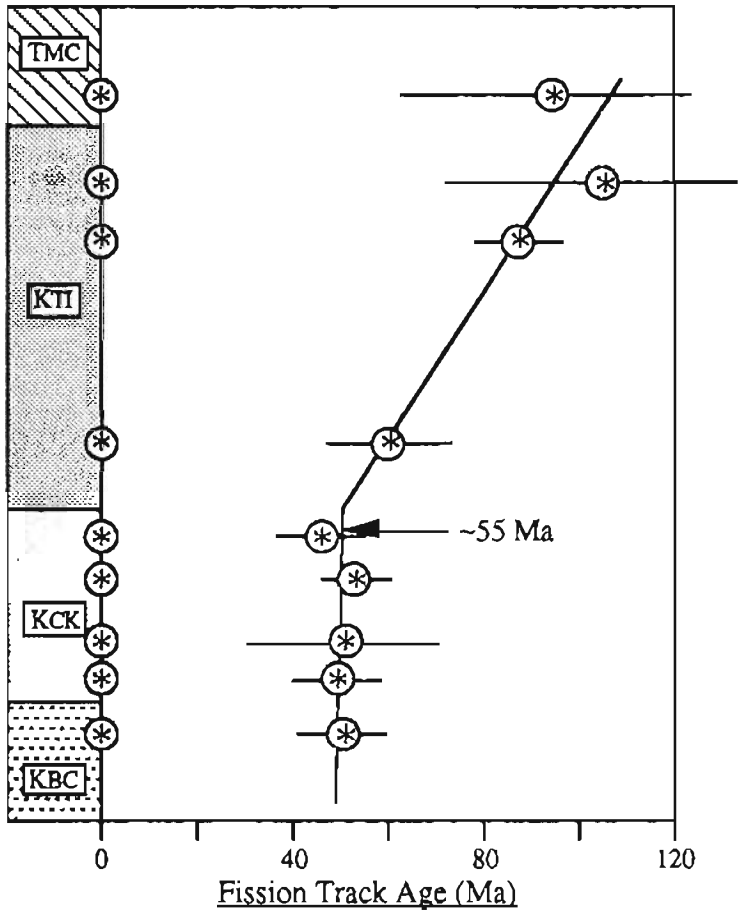


Figure 2. Apatite fission track results for samples from the Big Fish River section plotted against their relative position in the stratigraphic section shown along the left side. Error bars are two standard deviations. These define the "regional" pattern consisting of a two-stage uplift history; the "break in slope" in the apatite-age profile at ~55 Ma marking the base of the uplifted apatite annealing zone and the time of initiation of uplift of the base of the Big Fish River section. Samples above this "break" lay in the annealing zone prior to uplift and now have primarily mixed ages comprising an earlier set of partially annealed tracks and a later set of tracks accumulated subsequent to uplift. Samples lying below the "break in slope" had ages of zero prior to uplift and only started accumulating tracks once there were uplifted above the base of the annealing zone.

REFERENCES

Galbraith, R.F. (1981). On statistical models for fission track counts. Mathematical Geology, v. 13: 471-488.

Green, P.F. (1981). A new look at statistics in fission track dating. Nuclear Tracks 5: 77-86.

Green, P.F. (1986). On the thermo-tectonic evolution of Northern England: evidence from fission track analysis. Geology, v. 5: 493-506.

Green, P.F. (1989). Thermal and tectonic history of the East Midlands shelf (onshore UK) and surrounding regions assessed by apatite fission track analysis. Journal of the London Geological Society, v. 146: 755-773.

Green, P.F., Duddy, I.R., Laslett, G.M., Hegarty, K.A., Gleadow, A.J.W., and Lovering, J.F. (1989). Thermal annealing of fission tracks in apatite 4. Qualitative modelling techniques and extensions to geological timescales. Chemical Geology (Isotope Geoscience Section), v. 79: 155-182.

Hurford, A.J. and Green, P.F. (1982). A users' guide to fission-track dating calibration. Earth and Planetary Science Letters, v. 59: 343-354.

Hurford, A.J. and Green, P.F. (1983). The zeta age calibration of fission track dating. Isotope Geoscience 1: 285-317

Lal, D., Rajan, R.S. and Tamhane, A.S. (1969). Chemical composition of nuclei of $Z > 22$ in cosmic rays using meteoric minerals as detectors. Nature, v. 221: 33-37.

Laslett, G.M., Kendall, W.S., Gleadow, A.J.W. and Duddy, I.R. (1982). Bias in measurement of fission track length distributions. Nuclear Tracks 6: 79-85.

Moore, M.E., Gleadow, A.J.W. and Lovering, J.F. (1986). Thermal evolution of rifted continental margins: new evidence from fission tracks in basement apatites from southeastern Australia. Earth and Planetary Science Letters, v. 78: 255-270.

GRAIN-AGE DATA FROM BIG FISH RIVER SAMPLES

88 POS 01A APATITE Cuesta Creek Mem.

IRRADIATION LU029
SLIDE NUMBER 1
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	11	114	24	0.096	26.0	5.208E+05	5.398E+06	46.1 ± 14.6
2	18	132	50	0.136	14.4	4.091E+05	3.000E+06	65.1 ± 16.4
3	5	49	20	0.102	13.4	2.841E+05	2.784E+06	48.8 ± 22.9
4	3	27	30	0.111	4.9	1.136E+05	1.023E+06	53.1 ± 32.3
5	5	52	42	0.096	6.8	1.353E+05	1.407E+06	46.0 ± 21.5
6	6	70	15	0.086	25.5	4.545E+05	5.303E+06	41.0 ± 17.4
7	2	22	24	0.091	5.0	9.470E+04	1.042E+06	43.5 ± 32.1
8	5	69	24	0.072	15.7	2.367E+05	3.267E+06	34.7 ± 16.1
9	3	29	24	0.103	6.6	1.420E+05	1.373E+06	49.4 ± 30.0
10	3	14	12	0.214	6.4	2.841E+05	1.326E+06	102.0 ± 64.9
11	9	45	30	0.200	8.2	3.409E+05	1.705E+06	95.2 ± 34.8
12	6	25	28	0.240	4.9	2.435E+05	1.015E+06	114.1 ± 51.9
13	17	210	24	0.081	47.9	8.049E+05	9.943E+06	38.7 ± 9.8
14	0	2	24	0.000	0.5	0.000E+00	9.470E+04	0.0 ± 0.0
15	3	20	20	0.150	5.5	1.705E+05	1.136E+06	71.6 ± 44.3
16	14	160	40	0.088	21.9	3.977E+05	4.545E+06	41.8 ± 11.7
17	3	24	36	0.125	3.6	9.470E+04	7.576E+05	59.7 ± 36.6
18	4	22	30	0.182	4.0	1.515E+05	8.333E+05	86.6 ± 47.1
19	3	57	28	0.053	11.1	1.218E+05	2.313E+06	25.2 ± 14.9
20	8	79	56	0.101	7.7	1.623E+05	1.603E+06	48.4 ± 18.0
	128	1222			11.5	2.504E+05	2.390E+06	

Area of basic unit = 8.8E-07 cm-2

CHI SQUARED = 14.782 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 73.6 %
CORRELATION COEFFICIENT = 0.913
VARIANCE OF SQR(Ns) = 1.01
VARIANCE OF SQR(Ni) = 10.63

Ns/Ni = 0.105 ± 0.010
MEAN RATIO = 0.116 ± 0.013

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.720E+06cm-2; ND = 5975

POOLED AGE = 50.0 ± 4.7 Ma
MEAN AGE = 55.6 ± 6.2 Ma

88 POS 02A APATITE Cuesta Creek Mem.

IRRADIATION LU029
SLIDE NUMBER 2
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	7	41	36	0.171	6.2	2.210E+05	1.294E+06	81.4 ± 33.3
2	1	11	10	0.091	6.0	1.136E+05	1.250E+06	43.5 ± 45.4
3	3	37	60	0.081	3.4	5.682E+04	7.008E+05	38.8 ± 23.3
4	3	18	35	0.167	2.8	9.740E+04	5.844E+05	79.5 ± 49.6
5	1	46	45	0.022	5.6	2.525E+04	1.162E+06	10.4 ± 10.5
6	2	13	20	0.154	3.6	1.136E+05	7.386E+05	73.4 ± 55.7
7	1	27	30	0.037	4.9	3.788E+04	1.023E+06	17.7 ± 18.1
8	2	7	30	0.286	1.3	7.576E+04	2.652E+05	135.6 ± 108.8
9	0	5	15	0.000	1.8	0.000E+00	3.788E+05	0.0 ± 0.0
10	7	35	30	0.200	6.4	2.652E+05	1.326E+06	95.2 ± 39.5
11	3	26	12	0.115	11.9	2.841E+05	2.462E+06	55.1 ± 33.6
	30	266			4.5	1.055E+05	9.358E+05	

Area of basic unit = 8.8E-07 cm-2

CHI SQUARED = 10.566 WITH 10 DEGREES OF FREEDOM
P(chi squared) = 39.2 %
CORRELATION COEFFICIENT = 0.521
VARIANCE OF SQR(Ns) = 0.58
VARIANCE OF SQR(Ni) = 2.46

Ns/Ni = 0.113 ± 0.022
MEAN RATIO = 0.120 ± 0.026

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.720E+06cm-2; ND = 5975

POOLED AGE = 53.9 ± 10.4 Ma
MEAN AGE = 57.4 ± 12.3 Ma

88 POS 03A APATITE Cuesta Creek Mem.

IRRADIATION LU042
SLIDE NUMBER 1
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	30	228	49	0.132	24.9	6.803E+05	5.170E+06	62.8 ± 12.2
2	0	15	100	0.000	0.8	0.000E+00	1.667E+05	0.0 ± 0.0
3	10	83	100	0.120	4.4	1.111E+05	9.222E+05	57.5 ± 19.3
4	10	71	100	0.141	3.8	1.111E+05	7.889E+05	67.2 ± 22.7
5	50	438	100	0.114	23.4	5.556E+05	4.867E+06	54.5 ± 8.2
6	8	116	36	0.069	17.2	2.469E+05	3.580E+06	33.0 ± 12.1
7	13	102	100	0.127	5.5	1.444E+05	1.133E+06	60.8 ± 17.9
8	28	133	100	0.211	7.1	3.111E+05	1.478E+06	100.2 ± 20.9
9	9	103	90	0.087	6.1	1.111E+05	1.272E+06	41.8 ± 14.5
10	8	121	100	0.066	6.5	8.889E+04	1.344E+06	31.6 ± 11.6
11	35	289	49	0.121	31.6	7.936E+05	6.553E+06	57.8 ± 10.4
12	14	77	30	0.182	13.7	5.185E+05	2.852E+06	86.6 ± 25.2
13	5	91	48	0.055	10.1	1.157E+05	2.106E+06	26.3 ± 12.1
14	3	20	15	0.150	7.1	2.222E+05	1.481E+06	71.6 ± 44.3
15	0	41	64	0.000	3.4	0.000E+00	7.118E+05	0.0 ± 0.0
16	74	612	60	0.121	54.6	1.370E+06	1.133E+07	57.7 ± 7.2
17	4	42	16	0.095	14.0	2.778E+05	2.917E+06	45.5 ± 23.8
18	6	55	100	0.109	2.9	6.667E+04	6.111E+05	52.1 ± 22.4
19	6	67	25	0.090	14.3	2.667E+05	2.978E+06	42.8 ± 18.3
20	29	228	49	0.127	24.9	6.576E+05	5.170E+06	60.7 ± 12.0
	342	2932			11.8	2.855E+05	2.448E+06	

Area of basic unit = .0000009 cm-2

CHI SQUARED = 27.185 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 10.0 %
CORRELATION COEFFICIENT = 0.975
VARIANCE OF SQR(Ns) = 4.76
VARIANCE OF SQR(Ni) = 27.99

Ns/Ni = 0.117 ± 0.007
MEAN RATIO = 0.106 ± 0.012

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.720E+06cm-2; ND = 5975

POOLED AGE = 55.7 ± 3.3 Ma
MEAN AGE = 50.6 ± 5.6 Ma

88 POS 04A APATITE Cuesta Creek Mem.

IRRADIATION LU042
SLIDE NUMBER 2
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	5	37	50	0.135	4.0	1.111E+05	8.222E+05	64.5 ± 30.8
2	1	9	10	0.111	4.8	1.111E+05	1.000E+06	53.1 ± 56.0
3	8	67	49	0.119	7.3	1.814E+05	1.519E+06	57.0 ± 21.4
4	3	51	18	0.059	15.2	1.852E+05	3.148E+06	28.2 ± 16.7
5	1	7	24	0.143	1.6	4.630E+04	3.241E+05	68.2 ± 72.9
6	8	109	25	0.073	23.3	3.556E+05	4.844E+06	35.1 ± 12.9
7	6	64	40	0.094	8.6	1.667E+05	1.778E+06	44.8 ± 19.1
8	4	41	32	0.098	6.9	1.389E+05	1.424E+06	46.6 ± 24.4
9	8	90	40	0.089	12.0	2.222E+05	2.500E+06	42.5 ± 15.7
10	11	124	10	0.089	66.4	1.222E+06	1.378E+07	42.4 ± 13.4
11	6	38	40	0.158	5.1	1.667E+05	1.056E+06	75.3 ± 33.1
12	1	9	12	0.111	4.0	9.259E+04	8.333E+05	53.1 ± 56.0
13	3	28	16	0.107	9.4	2.083E+05	1.944E+06	51.2 ± 31.1
14	4	15	20	0.267	4.0	2.222E+05	8.333E+05	126.7 ± 71.3
15	4	41	36	0.098	6.1	1.235E+05	1.265E+06	46.6 ± 24.4
16	7	49	40	0.143	6.6	1.944E+05	1.361E+06	68.2 ± 27.6
17	2	17	49	0.118	1.9	4.535E+04	3.855E+05	56.2 ± 42.0
18	2	84	60	0.024	7.5	3.704E+04	1.556E+06	11.4 ± 8.2
19	8	65	40	0.123	8.7	2.222E+05	1.806E+06	58.8 ± 22.0
20	5	36	48	0.139	4.0	1.157E+05	8.333E+05	66.3 ± 31.7
	97	981			8.0	1.635E+05	1.654E+06	

Area of basic unit = .0000009 cm-2

CHI SQUARED = 13.469 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 81.4 %
CORRELATION COEFFICIENT = 0.790
VARIANCE OF SQR(Ns) = 0.48
VARIANCE OF SQR(Ni) = 6.05

Ns/Ni = 0.099 ± 0.011
MEAN RATIO = 0.115 ± 0.011

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.720E+06cm-2; ND = 5975

POOLED AGE = 47.3 ± 5.1 Ma
MEAN AGE = 54.8 ± 5.2 Ma

88 POS 05A APATITE Tent Island Fm.

IRRADIATION LU042
SLIDE NUMBER 3
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	19	148	36	0.128	22.0	5.864E+05	4.568E+06	61.3 ± 15.0
2	4	46	30	0.087	8.2	1.481E+05	1.704E+06	41.6 ± 21.7
3	4	44	25	0.091	9.4	1.778E+05	1.956E+06	43.5 ± 22.7
4	3	10	24	0.300	2.2	1.389E+05	4.630E+05	142.3 ± 93.7
5	0	22	28	0.000	4.2	0.000E+00	8.730E+05	0.0 ± 0.0
6	62	457	45	0.136	54.3	1.531E+06	1.128E+07	64.7 ± 8.8
7	31	192	30	0.161	34.2	1.148E+06	7.111E+06	77.0 ± 15.0
8	9	76	24	0.118	16.9	4.167E+05	3.519E+06	56.6 ± 20.0
9	18	163	36	0.110	24.2	5.556E+05	5.031E+06	52.8 ± 13.1
10	40	364	36	0.110	54.1	1.235E+06	1.123E+07	52.5 ± 8.8
11	4	27	56	0.148	2.6	7.936E+04	5.357E+05	70.7 ± 37.9
12	4	14	20	0.286	3.7	2.222E+05	7.778E+05	135.6 ± 76.9
13	30	287	20	0.105	76.8	1.667E+06	1.594E+07	49.9 ± 9.6
14	4	36	28	0.111	6.9	1.587E+05	1.429E+06	53.1 ± 28.0
15	32	272	28	0.118	52.0	1.270E+06	1.079E+07	56.2 ± 10.5
16	6	107	24	0.056	23.9	2.778E+05	4.954E+06	26.8 ± 11.3
17	79	439	42	0.180	55.9	2.090E+06	1.161E+07	85.7 ± 10.6
18	13	121	36	0.107	18.0	4.012E+05	3.735E+06	51.3 ± 15.0
19	9	118	40	0.076	15.8	2.500E+05	3.278E+06	36.5 ± 12.6
20	9	143	70	0.063	10.9	1.429E+05	2.270E+06	30.1 ± 10.4
21	15	93	30	0.161	16.6	5.556E+05	3.444E+06	76.9 ± 21.4
	395	3179			24.0	6.199E+05	4.989E+06	

Area of basic unit = .0000009 cm-2

CHI SQUARED = 32.203 WITH 20 DEGREES OF FREEDOM
P(chi squared) = 4.1 %
CORRELATION COEFFICIENT = 0.952
VARIANCE OF SQR(Ns) = 4.87
VARIANCE OF SQR(Ni) = 30.40

Ns/Ni = 0.124 ± 0.007
MEAN RATIO = 0.126 ± 0.015

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.720E+06cm-2; ND = 5975

POOLED AGE = 59.3 ± 3.3 Ma
MEAN AGE = 60.3 ± 7.2 Ma

88 POS 06C APATITE Boundary Creek Fm.

IRRADIATION LU042
SLIDE NUMBER 4
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	5	53	50	0.094	5.7	1.111E+05	1.178E+06	45.1 ± 21.1
2	8	78	60	0.103	7.0	1.481E+05	1.444E+06	49.0 ± 18.2
3	18	111	80	0.162	7.4	2.500E+05	1.542E+06	77.3 ± 19.7
4	10	89	60	0.112	7.9	1.852E+05	1.648E+06	53.7 ± 17.9
5	7	77	80	0.091	5.2	9.722E+04	1.069E+06	43.5 ± 17.2
6	15	104	80	0.144	7.0	2.083E+05	1.444E+06	68.8 ± 19.0
7	8	70	60	0.114	6.2	1.481E+05	1.296E+06	54.6 ± 20.4
8	7	79	70	0.089	6.0	1.111E+05	1.254E+06	42.4 ± 16.7
9	6	57	40	0.105	7.6	1.667E+05	1.583E+06	50.3 ± 21.6
10	9	56	50	0.161	6.0	2.000E+05	1.244E+06	76.6 ± 27.6
11	15	88	70	0.170	6.7	2.381E+05	1.397E+06	81.2 ± 22.7
12	5	75	70	0.067	5.7	7.936E+04	1.190E+06	31.9 ± 14.7
13	8	69	50	0.116	7.4	1.778E+05	1.533E+06	55.4 ± 20.7
14	6	55	60	0.109	4.9	1.111E+05	1.019E+06	52.1 ± 22.4
15	8	69	70	0.116	5.3	1.270E+05	1.095E+06	55.4 ± 20.7
16	4	61	70	0.066	4.7	6.349E+04	9.683E+05	31.4 ± 16.2
17	7	67	60	0.104	6.0	1.296E+05	1.241E+06	49.9 ± 19.8
18	7	78	56	0.090	7.5	1.389E+05	1.548E+06	42.9 ± 16.9
19	9	75	60	0.120	6.7	1.667E+05	1.389E+06	57.3 ± 20.2
20	4	65	70	0.062	5.0	6.349E+04	1.032E+06	29.5 ± 15.2
	166	1476			6.2	1.457E+05	1.295E+06	

Area of basic unit = .0000009 cm-2

CHI SQUARED = 11.305 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 91.3 %
CORRELATION COEFFICIENT = 0.829
VARIANCE OF SQR(Ns) = 0.36
VARIANCE OF SQR(Ni) = 0.77

Ns/Ni = 0.112 ± 0.009
MEAN RATIO = 0.110 ± 0.007

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.720E+06cm-2; ND = 5975

POOLED AGE = 53.7 ± 4.5 Ma
MEAN AGE = 52.4 ± 3.4 Ma

88 POS 08A APATITE Tent Island Fm.

IRRADIATION LU042
SLIDE NUMBER 5
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	22	63	36	0.349	9.4	6.790E+05	1.944E+06	165.4 ± 41.0
2	8	28	25	0.286	6.0	3.556E+05	1.244E+06	135.6 ± 54.4
3	19	113	70	0.168	8.6	3.016E+05	1.794E+06	80.2 ± 19.9
4	3	30	20	0.100	8.0	1.667E+05	1.667E+06	47.8 ± 28.9
5	3	18	49	0.167	2.0	6.803E+04	4.082E+05	79.5 ± 49.6
6	2	17	24	0.118	3.8	9.259E+04	7.870E+05	56.2 ± 42.0
7	1	15	25	0.067	3.2	4.444E+04	6.667E+05	31.9 ± 32.9
8	69	428	60	0.161	38.2	1.278E+06	7.926E+06	76.9 ± 10.1
9	7	59	21	0.119	15.0	3.704E+05	3.122E+06	56.7 ± 22.7
10	6	42	20	0.143	11.2	3.333E+05	2.333E+06	68.2 ± 29.8
11	36	221	20	0.163	59.1	2.000E+06	1.228E+07	77.7 ± 14.0
12	25	169	48	0.148	18.8	5.787E+05	3.912E+06	70.6 ± 15.2
13	1	10	25	0.100	2.1	4.444E+04	4.444E+05	47.8 ± 50.1
14	4	24	16	0.167	8.0	2.778E+05	1.667E+06	79.5 ± 42.9
15	0	11	12	0.000	4.9	0.000E+00	1.019E+06	0.0 ± 0.0
16	14	74	80	0.189	4.9	1.944E+05	1.028E+06	90.1 ± 26.3
17	8	27	15	0.296	9.6	5.926E+05	2.000E+06	140.6 ± 56.6
18	11	71	30	0.155	12.7	4.074E+05	2.630E+06	73.9 ± 24.0
19	2	13	24	0.154	2.9	9.259E+04	6.019E+05	73.4 ± 55.7
20	95	365	35	0.260	55.8	3.016E+06	1.159E+07	123.7 ± 14.4
21	21	160	32	0.131	26.8	7.292E+05	5.556E+06	62.7 ± 14.6
	357	1958			15.3	5.774E+05	3.167E+06	

Area of basic unit = .0000009 cm-2

CHI SQUARED = 30.517 WITH 20 DEGREES OF FREEDOM
P(chi squared) = 6.2 %
CORRELATION COEFFICIENT = 0.949
VARIANCE OF SQR(Ns) = 5.92
VARIANCE OF SQR(Ni) = 26.43

Ns/Ni = 0.182 ± 0.010
MEAN RATIO = 0.164 ± 0.017

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.720E+06cm-2; ND = 5975

POOLED AGE = 86.9 ± 5.2 Ma
MEAN AGE = 78.1 ± 8.4 Ma

88 POS 09A APATITE Tent Island Fm.

IRRADIATION LU042
SLIDE NUMBER 6
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	1	6	4	0.167	8.0	2.778E+05	1.667E+06	79.5 ± 85.8
2	3	6	8	0.500	4.0	4.167E+05	8.333E+05	235.5 ± 166.6
3	2	18	12	0.111	8.0	1.852E+05	1.667E+06	53.1 ± 39.6
4	1	4	6	0.250	3.6	1.852E+05	7.407E+05	118.8 ± 132.9
5	1	10	4	0.100	13.4	2.778E+05	2.778E+06	47.8 ± 50.1
6	1	2	10	0.500	1.1	1.111E+05	2.222E+05	235.5 ± 288.4
7	1	3	12	0.333	1.3	9.259E+04	2.778E+05	157.9 ± 182.4
8	11	64	9	0.172	38.1	1.358E+06	7.901E+06	81.9 ± 26.8
9	3	12	12	0.250	5.4	2.778E+05	1.111E+06	118.8 ± 76.7
10	1	7	8	0.143	4.7	1.389E+05	9.722E+05	68.2 ± 72.9
11	0	2	6	0.000	1.8	0.000E+00	3.704E+05	0.0 ± 0.0
12	1	7	6	0.143	6.2	1.852E+05	1.296E+06	68.2 ± 72.9
13	6	23	9	0.261	13.7	7.407E+05	2.840E+06	123.9 ± 56.9
14	0	1	6	0.000	0.9	0.000E+00	1.852E+05	0.0 ± 0.0
15	2	3	14	0.667	1.1	1.587E+05	2.381E+05	312.1 ± 285.0
16	1	4	10	0.250	2.1	1.111E+05	4.444E+05	118.8 ± 132.9
17	2	5	10	0.400	2.7	2.222E+05	5.556E+05	189.1 ± 158.2
18	4	15	12	0.267	6.7	3.704E+05	1.389E+06	126.7 ± 71.3
19	4	17	12	0.235	7.6	3.704E+05	1.574E+06	111.9 ± 62.2
20	4	9	8	0.444	6.0	5.556E+05	1.250E+06	209.7 ± 126.1
21	10	44	10	0.227	23.5	1.111E+06	4.889E+06	108.1 ± 37.9
	59	262			7.5	3.487E+05	1.548E+06	

Area of basic unit = .0000009 cm-2

CHI SQUARED = 8.903 WITH 20 DEGREES OF FREEDOM
P(chi squared) = 98.4 %
CORRELATION COEFFICIENT = 0.940
VARIANCE OF SQR(Ns) = 0.72
VARIANCE OF SQR(Ni) = 3.04

Ns/Ni = 0.225 ± 0.032
MEAN RATIO = 0.258 ± 0.037

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.720E+06cm-2; ND = 5975

POOLED AGE = 107.1 ± 15.5 Ma
MEAN AGE = 122.6 ± 17.6 Ma

88 POS 14A APATITE Moose Channel Fm.

IRRADIATION LU042
SLIDE NUMBER 8
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	15	91	72	0.165	6.8	2.315E+05	1.404E+06	78.6 ± 21.9
2	25	201	70	0.124	15.4	3.968E+05	3.190E+06	59.4 ± 12.6
3	26	174	24	0.149	38.8	1.204E+06	8.056E+06	71.3 ± 15.0
4	13	176	48	0.074	19.6	3.009E+05	4.074E+06	35.3 ± 10.2
5	15	90	70	0.167	6.9	2.381E+05	1.429E+06	79.5 ± 22.2
6	6	29	49	0.207	3.2	1.361E+05	6.576E+05	98.5 ± 44.2
7	13	48	49	0.271	5.2	2.948E+05	1.088E+06	128.6 ± 40.3
8	42	210	56	0.200	20.1	8.333E+05	4.167E+06	95.2 ± 16.2
9	3	3	50	1.000	0.3	6.667E+04	6.667E+04	462.7 ± 377.8
10	33	347	70	0.095	26.5	5.238E+05	5.508E+06	45.5 ± 8.3
11	62	352	32	0.176	58.9	2.153E+06	1.222E+07	83.9 ± 11.6
12	20	214	60	0.093	19.1	3.704E+05	3.963E+06	44.7 ± 10.5
13	33	321	24	0.103	71.6	1.528E+06	1.486E+07	49.1 ± 9.0
14	50	372	49	0.134	40.6	1.134E+06	8.435E+06	64.2 ± 9.7
15	38	159	60	0.239	14.2	7.037E+05	2.944E+06	113.6 ± 20.6
16	85	427	60	0.199	38.1	1.574E+06	7.907E+06	94.8 ± 11.4
17	4	38	48	0.105	4.2	9.259E+04	8.796E+05	50.3 ± 26.5
18	16	91	80	0.176	6.1	2.222E+05	1.264E+06	83.8 ± 22.8
19	10	33	42	0.303	4.2	2.646E+05	8.730E+05	143.7 ± 51.9
20	34	214	70	0.159	16.4	5.397E+05	3.397E+06	75.8 ± 14.0
21	30	208	40	0.144	27.8	8.333E+05	5.778E+06	68.8 ± 13.5
22	12	79	40	0.152	10.6	3.333E+05	2.194E+06	72.5 ± 22.5
23	31	200	40	0.155	26.8	8.611E+05	5.556E+06	73.9 ± 14.3
	616	4077			18.1	5.689E+05	3.766E+06	

Area of basic unit = .0000009 cm-2

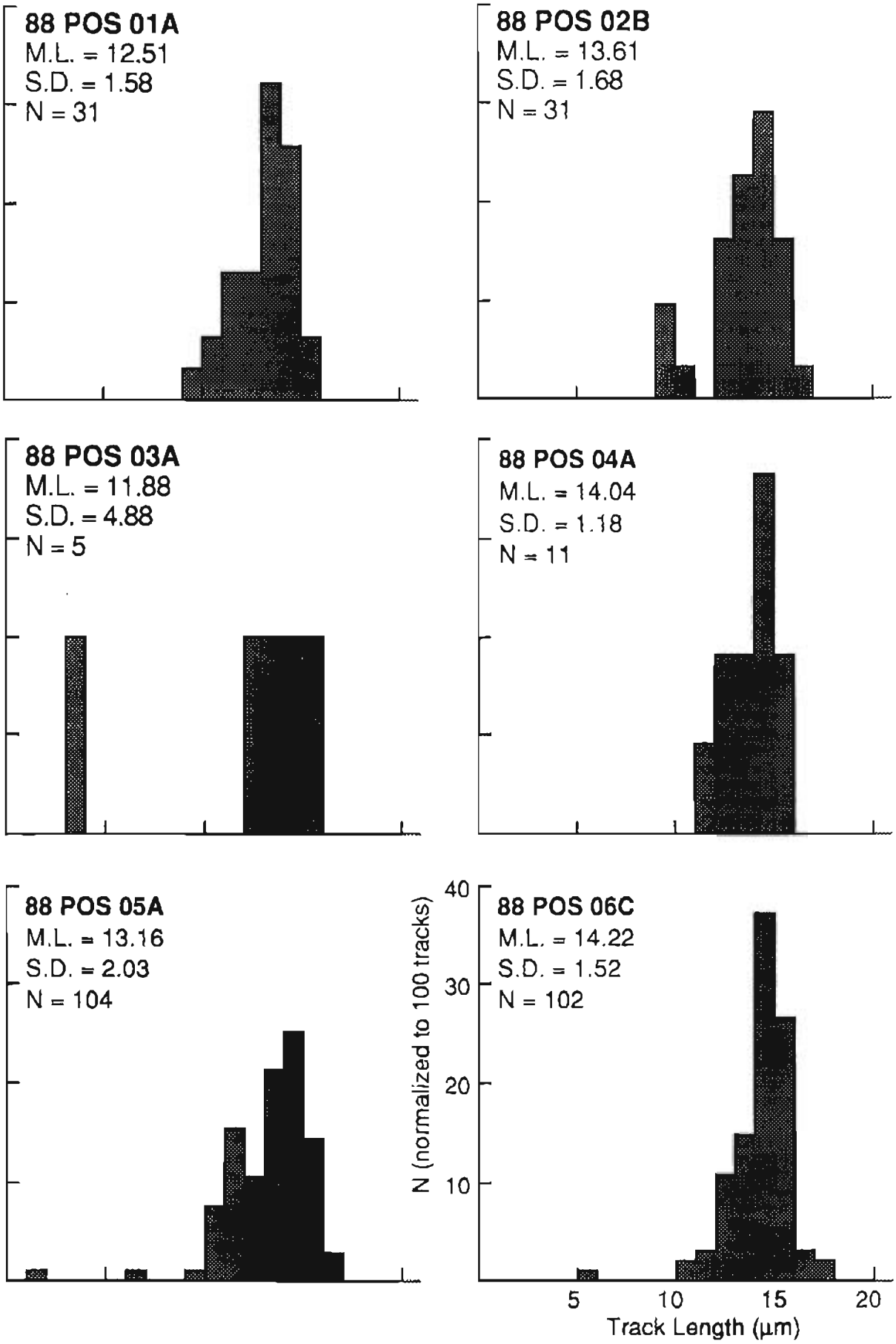
CHI SQUARED = 55.554 WITH 22 DEGREES OF FREEDOM
P(chi squared) = 0.0 %
CORRELATION COEFFICIENT = 0.883
VARIANCE OF SQR(Ns) = 3.43
VARIANCE OF SQR(Ni) = 25.67

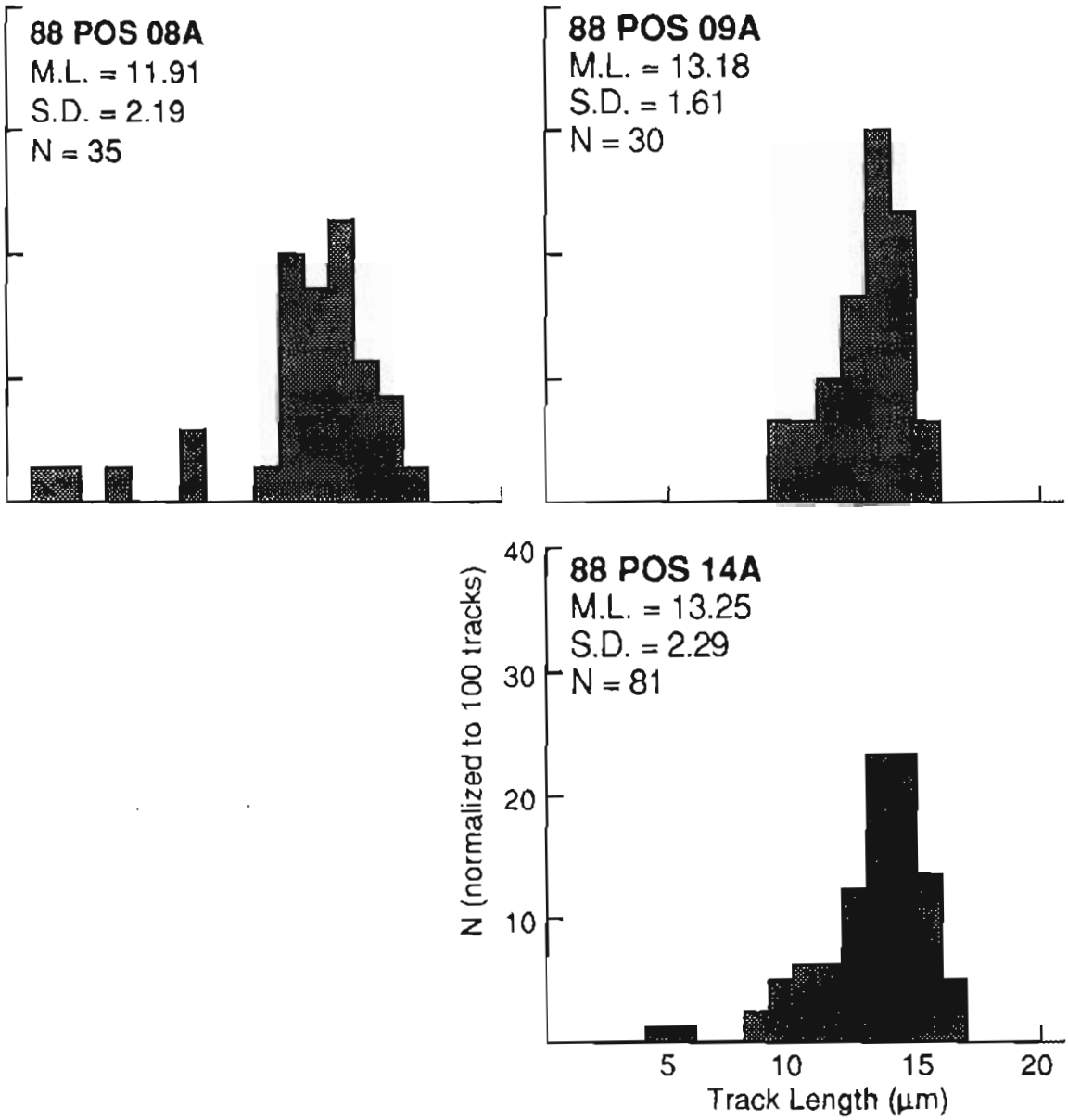
Ns/Ni = 0.151 ± 0.007
MEAN RATIO = 0.200 ± 0.038

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.720E+06cm-2; ND = 5975

POOLED AGE = 72.1 ± 3.3 Ma
MEAN AGE = 95.0 ± 18.3 Ma

CONFINED TRACK LENGTH DISTRIBUTIONS




88 POS 08A
M.L. = 11.91
S.D. = 2.19
N = 35
88 POS 09A
M.L. = 13.18
S.D. = 1.61
N = 30
88 POS 14A
M.L. = 13.25
S.D. = 2.29
N = 81
N (normalized to 100 tracks)
40
30
20
10
5
10
15
20
Track Length (µm)