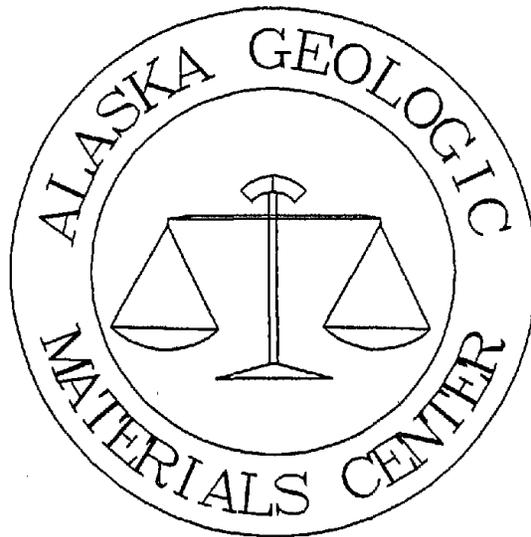


Preliminary results of three apatite fission track analyses of core (4296'-4593') and of cuttings (9500'-12400') from the Union Oil Company of California E de K Leffingwell No.1 well, North Slope, Alaska.



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Total of 8 pages in report

**Alaska Geologic Materials Center Data Report No. 198**

**Preliminary Results of 3 Apatite Fission Track Analyses of Samples From  
Leffingwell #1, North Slope, Alaska.**

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May, 1992

## INTRODUCTION

This is a preliminary report of apatite fission track analyses of 3 samples from the Leffingwell #1 well, northern Alaska. The samples were collected by O'Sullivan and Murphy during the 1991 field season from the Alaska Division of Geological and Geophysical Surveys Geologic Materials Center, Eagle River. Samples were processed and counted by O'Sullivan in the laboratories of the La Trobe University Fission Track Research Group, Melbourne, Australia. Grain mounts used for both age and length data are available from the Alaska Geologic Materials Center. Support for this work was by a grant to the authors from the American Chemical Society - Petroleum Research Fund.

A guide to read the information is as follows:

91POS03A	-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 <sup>2</sup> )
RHOi	-Density of induced tracks (per cm <sup>2</sup> )
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)
CENTRAL AGE	-Age calculated using weighted "Mean Ratio" (multiple populations; fail Chi-Squared test)

The track length distributions for each sample are shown on histograms showing the relative numbers of tracks measured in a particular class-interval. Analytical data including age data, mean confined track lengths, standard deviations and the total number of tracks measured for each sample are in Table 1.

## TECHNIQUES

Apatites (and zircons) were separated from samples by conventional heavy liquid and magnetic techniques. The apatite separates were mounted in epoxy resin on glass slides, ground and polished to expose internal surfaces of the grains, then etched in 5M Nitric acid to reveal the fossil fission tracks. Neutron irradiations were carried out in a well thermalized neutron flux in the Australian Atomic Energy Commissions HIFAR reactor. Thermal neutron fluences were monitored by counting tracks recorded in external muscovite detectors attached to 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 20-25 grains were counted on each mount. For further description of fission track counting methodology see Moore et al. (1986) and Green (1986).

Fission track ages were calculated using the zeta calibration method and standard fission track age equation (Hurford and Green, 1982). Errors were calculated using the techniques of 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 the Chi squared statistical test (Galbraith, 1981), the central age is reported (Galbraith, in press). 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 evidence of a asymmetric spread of single grain ages. An asymmetric spread in individual grain ages can result either from inheritance of detrital grains from mixed detrital source areas, or from differential annealing in grains of different compositions (Green et al. 1989).

Lengths of confined tracks (Lal et al. 1969) 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 as those employed for age determination (e.g. 1250x, dry objective). The lengths of suitable tracks were measured using a projection tube and a Hipad™ digitizing tablet calibrated using a stage micrometer (with  $\mu\text{m}$  divisions). Table 2 shows the number of tracks per class-interval used in plotting each track length distribution histogram.

## SAMPLE RESULTS

Table 1. Apatite fission track analytical results: Leffingwell #1

Sample Number	Number of grains	Standard track density ( $\times 10^6 \text{cm}^{-2}$ )	Fossil track density ( $\times 10^5 \text{cm}^{-2}$ )	Induced track density ( $\times 10^6 \text{cm}^{-2}$ )	Chi square probability (%)	Fission track age (Ma)	Uranium (ppm)	Mean track length ( $\mu\text{m}$ )	Standard deviation ( $\mu\text{m}$ )
91POS05A	25	1.406 (3164)	3.859 (265)	1.271 (873)	5.3	74.8 $\pm$ 5.5	11.8	12.89 $\pm$ 0.15 (100)	1.54
91POS03A	25	1.406 (3164)	2.802 (118)	93.54 (394)	100	73.8 $\pm$ 7.9	8.7	10.68 $\pm$ 0.30 (31)	1.68
91POS04A	20	1.406 (3164)	1.724 (72)	62.98 (263)	98.4	67.5 $\pm$ 9.1	5.9	10.60 $\pm$ 0.33 (21)	1.49

Brackets show number of tracks counted.

Standard and induced track densities measured on mica external detectors ( $g=0.5$ ), and fossil track densities on internal mineral surfaces.

\* Central age, used where pooled data fail  $\chi^2$  test at 5%. Errors quoted at  $\pm 1\text{s}$ .

Ages for samples calculated using  $z=352.7$  for dosimeter glass SRM612.

Samples listed by depth from top to bottom.

Table 2. Track length data: Leffingwell #1

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
POS05A	-	-	-	-	3	3	5	13	23	30	19	3	1	-
POS03A	-	-	1	-	5	3	7	8	4	2	1	-	-	-
POS04A	-	-	-	-	2	7	4	3	3	2	-	-	-	-

Length measurements by P. O'Sullivan

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AFTA DATA FROM LEFFINGWELL #1

91POS05A - 4296'-4593'

IRRADIATION LU194

SLIDE NUMBER 6

COUNTED BY: P. O'Sullivan

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	5	19	20	0.263	9.8	2.778E+05	1.056E+06	64.9 ± 32.7
2	6	22	36	0.273	6.3	1.852E+05	6.790E+05	67.3 ± 31.0
3	4	18	30	0.222	6.2	1.481E+05	6.667E+05	54.9 ± 30.4
4	68	152	36	0.447	43.7	2.099E+06	4.691E+06	110.0 ± 16.2
5	0	4	12	0.000	3.4	0.000E+00	3.704E+05	0.0 ± 0.0
6	2	10	25	0.200	4.1	8.889E+04	4.444E+05	49.4 ± 38.3
7	5	20	63	0.250	3.3	8.818E+04	3.527E+05	61.7 ± 30.9
8	0	1	24	0.000	0.4	0.000E+00	4.630E+04	0.0 ± 0.0
9	3	4	30	0.750	1.4	1.111E+05	1.481E+05	183.3 ± 140.1
10	7	15	20	0.467	7.8	3.889E+05	8.333E+05	114.7 ± 52.6
11	7	23	60	0.304	4.0	1.296E+05	4.259E+05	75.0 ± 32.4
12	2	8	20	0.250	4.1	1.111E+05	4.444E+05	61.7 ± 48.8
13	9	23	24	0.391	9.9	4.167E+05	1.065E+06	96.3 ± 37.9
14	5	35	30	0.143	12.1	1.852E+05	1.296E+06	35.3 ± 16.9
15	35	214	36	0.164	61.5	1.080E+06	6.605E+06	40.4 ± 7.4
16	4	8	32	0.500	2.6	1.389E+05	2.778E+05	122.8 ± 75.2
17	10	35	16	0.286	22.6	6.944E+05	2.431E+06	70.5 ± 25.3
18	21	50	28	0.420	18.5	8.333E+05	1.984E+06	103.3 ± 27.0
19	8	14	36	0.571	4.0	2.469E+05	4.321E+05	140.2 ± 62.2
20	13	24	15	0.542	16.6	9.630E+05	1.778E+06	132.9 ± 45.9
21	6	14	36	0.429	4.0	1.852E+05	4.321E+05	105.4 ± 51.5
22	28	110	30	0.255	38.0	1.037E+06	4.074E+06	62.8 ± 13.4
23	2	9	54	0.222	1.7	4.115E+04	1.852E+05	54.9 ± 42.9
24	10	25	30	0.400	8.6	3.704E+05	9.259E+05	98.4 ± 36.9
25	5	16	20	0.312	8.3	2.778E+05	8.889E+05	77.0 ± 39.5
	265	873			11.8	3.859E+05	1.271E+06	

Area of basic unit = .0000009 cm-2

Chi Squared = 36.135 with 24 degrees of freedom

P(chi squared) = 5.3 %

Correlation Coefficient = 0.856

Variance of SQR(Ns) = 3.13

Variance of SQR(Ni) = 10.01

Age Dispersion = 25.076 %

Ns/Ni = 0.304 ± 0.021

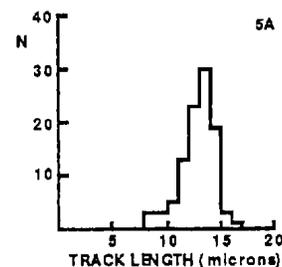
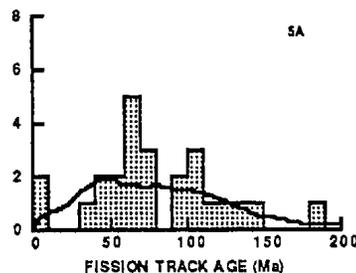
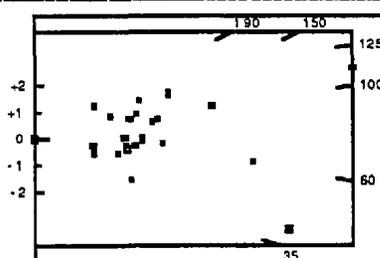
Mean Ratio = 0.322 ± 0.035

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass

Rho D = 1.406E+06cm-2; ND = 3164

**POOLED AGE = 74.8 ± 5.5 Ma****CENTRAL AGE = 78.0 ± 7.8 Ma**

91POS05A APATITE 4296'-4593'



91POS03A - 9500'-10200'

IRRADIATION LU194

SLIDE NUMBER 4

COUNTED BY: P. O'Sullivan

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	3	9	20	0.333	4.7	1.667E+05	5.000E+05	82.1 ± 54.8
2	1	4	10	0.250	4.1	1.111E+05	4.444E+05	61.7 ± 69.0
3	2	10	9	0.200	11.5	2.469E+05	1.235E+06	49.4 ± 38.3
4	4	15	20	0.267	7.8	2.222E+05	8.333E+05	65.8 ± 37.0
5	1	1	15	1.000	0.7	7.407E+04	7.407E+04	243.3 ± 344.1
6	14	57	24	0.246	24.6	6.481E+05	2.639E+06	60.6 ± 18.1
7	1	1	21	1.000	0.5	5.291E+04	5.291E+04	243.3 ± 344.1
8	3	7	15	0.429	4.8	2.222E+05	5.185E+05	105.4 ± 72.8
9	1	5	24	0.200	2.2	4.630E+04	2.315E+05	49.4 ± 54.1
10	2	2	9	1.000	2.3	2.469E+05	2.469E+05	243.3 ± 243.4
11	4	13	18	0.308	7.5	2.469E+05	8.025E+05	75.8 ± 43.4
12	2	10	12	0.200	8.6	1.852E+05	9.259E+05	49.4 ± 38.3
13	1	5	30	0.200	1.7	3.704E+04	1.852E+05	49.4 ± 54.1
14	3	8	12	0.375	6.9	2.778E+05	7.407E+05	92.3 ± 62.5
15	2	8	20	0.250	4.1	1.111E+05	4.444E+05	61.7 ± 48.8
16	19	61	25	0.311	25.3	8.444E+05	2.711E+06	76.8 ± 20.2
17	1	1	16	1.000	0.6	6.944E+04	6.944E+04	243.3 ± 344.1
18	3	9	30	0.333	3.1	1.111E+05	3.333E+05	82.1 ± 54.8
19	3	15	8	0.200	19.4	4.167E+05	2.083E+06	49.4 ± 31.3
20	10	33	30	0.303	11.4	3.704E+05	1.222E+06	74.7 ± 27.0
21	7	18	21	0.389	8.9	3.704E+05	9.524E+05	95.7 ± 42.7
22	5	23	18	0.217	13.2	3.086E+05	1.420E+06	53.7 ± 26.5
23	20	61	24	0.328	26.3	9.259E+05	2.824E+06	80.8 ± 20.9
24	4	12	28	0.333	4.4	1.587E+05	4.762E+05	82.1 ± 47.5
25	2	6	9	0.333	6.9	2.469E+05	7.407E+05	82.1 ± 67.1
	118	394			8.7	2.802E+05	9.354E+05	

Area of basic unit = .0000009 cm-2

Chi Squared = 7.307 with 24 degrees of freedom

P(chi squared) = 100.0 %

Correlation Coefficient = 0.979

Variance of SQR(Ns) = 1.02

Variance of SQR(Ni) = 3.88

Age Dispersion = 0.000 % (did not converge)

Ns/Ni = 0.299 ± 0.031

Mean Ratio = 0.400 ± 0.055

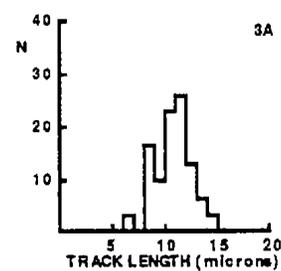
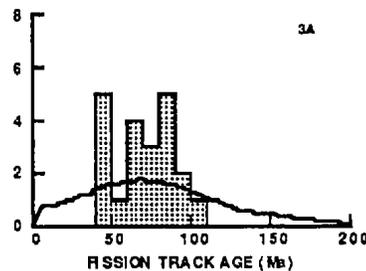
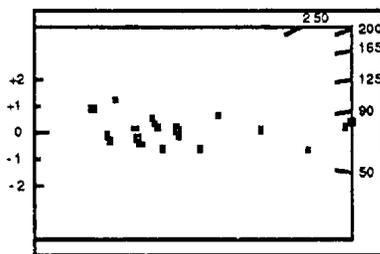
Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass

Rho D = 1.406E+06cm-2; ND = 3164

POOLED AGE = 73.8 ± 7.9 Ma

CENTRAL AGE = 73.8 ± 7.9 Ma

91POS03A APATITE 9500'-10200'



91POS04A - 11700'-12400'

IRRADIATION LU194

SLIDE NUMBER 5

COUNTED BY: P. O'Sullivan

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	4	15	16	0.267	9.7	2.778E+05	1.042E+06	65.8 ± 37.0
2	1	1	16	1.000	0.6	6.944E+04	6.944E+04	243.3 ± 344.1
3	9	35	9	0.257	40.3	1.111E+06	4.321E+06	63.4 ± 23.8
4	1	1	16	1.000	0.6	6.944E+04	6.944E+04	243.3 ± 344.1
5	3	8	15	0.375	5.5	2.222E+05	5.926E+05	92.3 ± 62.5
6	1	6	12	0.167	5.2	9.259E+04	5.556E+05	41.2 ± 44.5
7	1	1	25	1.000	0.4	4.444E+04	4.444E+04	243.3 ± 344.1
8	2	8	15	0.250	5.5	1.481E+05	5.926E+05	61.7 ± 48.8
9	5	22	30	0.227	7.6	1.852E+05	8.148E+05	56.1 ± 27.8
10	20	65	30	0.308	22.4	7.407E+05	2.407E+06	75.8 ± 19.5
11	3	8	40	0.375	2.1	8.333E+04	2.222E+05	92.3 ± 62.5
12	7	19	70	0.368	2.8	1.111E+05	3.016E+05	90.7 ± 40.2
13	0	1	16	0.000	0.6	0.000E+00	6.944E+04	0.0 ± 0.0
14	7	29	48	0.241	6.3	1.620E+05	6.713E+05	59.6 ± 25.1
15	1	6	16	0.167	3.9	6.944E+04	4.167E+05	41.2 ± 44.5
16	0	11	16	0.000	7.1	0.000E+00	7.639E+05	0.0 ± 0.0
17	3	9	20	0.333	4.7	1.667E+05	5.000E+05	82.1 ± 54.8
18	1	4	12	0.250	3.4	9.259E+04	3.704E+05	61.7 ± 69.0
19	2	10	30	0.200	3.4	7.407E+04	3.704E+05	49.4 ± 38.3
20	1	4	12	0.250	3.4	9.259E+04	3.704E+05	61.7 ± 69.0
	72	263			5.9	1.724E+05	6.298E+05	

Area of basic unit = .0000009 cm-2

Chi Squared = 8.246 with 19 degrees of freedom

P(chi squared) = 98.4 %

Correlation Coefficient = 0.971

Variance of SQR(Ns) = 1.09

Variance of SQR(Ni) = 3.35

Age Dispersion = 0.000 % (did not converge)

Ns/Ni = 0.274 ± 0.036

Mean Ratio = 0.352 ± 0.066

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass

Rho D = 1.406E+06cm-2; ND = 3164

**POOLED AGE = 67.5 ± 9.1 Ma****CENTRAL AGE = 67.5 ± 9.1 Ma**

91POS04A APATITE 11700'-12400'

