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Apatite Fission-track Analysis of Twelve Outcrop Samples from the Chandler Lake and Killik River 1:250,000-scale Quadrangles, South-central North Slope, Alaska

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INTRODUCTION

This Open-File report releases to the public the results of apatite fission-track analysis (AFTA) of twelve rock samples from the south-central North Slope of Alaska. These samples were collected by geologists of the U.S. Geological Survey from rock outcrops of Early Cretaceous age in the Killik River and Chandler Lake 1:250,000-scale quadrangles during July, 1999 as part of a petroleum resource investigation of the National Petroleum Reserve, Alaska (NPRA). The fission-track investigation was undertaken for the purpose of determining the thermal-chronologic history of the subsurface section in NPRA. Laboratory analysis of the samples was completed by GeoTrack Inernational on contract to the U.S. Geological Survey. This report contains the raw data results of GeoTrack's apatite fission-track analysis without interpretation. Interpretations of the raw data released here will be made and presented elsewhere at a later date.

The locations, the stratigraphic age, rock formation assignment, and apatite yields from the twelve samples are present in Table 1. The analytical results of the apatite fission-track analysis are presented in Table 2 and a summary of the length distribution data is presented in Table 3. Following a discussion provided by GeoTrack of the sample preparation techniques used for the analysis, background information about the methods of determining apatite fission-track ages, and methods of reporting fission-track data, the results of the analysis are presented in individual data sheets by sample number. The data sheets include both tabular and graphical presentations of the fission-track results. The results include fission-track ages (both individual grains and mean age), confined length measurements, and the chlorine content of each age grain.

The quality of the AFTA results reported here is excellent. Apatite yields in all samples were excellent, with all samples providing twenty or more grains for fission track age determination. The apatite grains are detrital grains of very good quality. In most samples, the apatite grains are euhedral with a small number of rounded and angular grains observed in all samples. Overall, the samples provided age and length data of excellent quality.

SAMPLE PREPARATION

Core and outcrop samples are crushed in a jaw crusher and then ground to sand grade in a rotary disc mill. Cuttings samples are washed and dried before grinding to sand grade.

The ground material is then washed to remove dust, dried and processed by conventional heavy liquid and magnetic separation techniques to recover heavy minerals. Apatite grains are mounted in epoxy resin on glass slides, polished and etched for 20 sec in 5M HNO_3 at 20°C to reveal the fossil fission tracks.

After etching, all mounts are cut down to 1.5 X 1 cm, and cleaned in detergent, alcohol and distilled water. The mounts are then sealed in intimate contact with low-uranium muscovite detectors within heat shrink plastic film. Each batch of mounts is stacked between two pieces of uranium standard glass which has been prepared in similar fashion. The stack is then inserted into an aluminium can for irradiation.

After irradiation, the mica detectors are removed from the grain mounts and standard glasses and etched in hydrofluoric acid to reveal the fission tracks produced by induced fission of ^{235}U in the apatite and standard glass.

FISSION-TRACK AGES

Fission-track ages are calculated using the standard fission track age equation using the zeta calibration method (equation 5 of Hurford and Green, 1983), viz:

$$\text{F.T. AGE} = \frac{1}{\lambda_D} \ln \left[1 + \left(\frac{\zeta \lambda_D \rho_s g \rho_D}{\rho_i} \right) \right] \qquad \text{equation 1}$$

where:

λ_D = total decay constant of ^{238}U (= 1.55125×10^{-10})
ζ = Zeta calibration factor
ρ_s = Spontaneous track density
ρ_i = Induced track density
ρ_D = Track density from uranium standard glass
g = A geometry factor (= 0.5)

Fission track ages are determined by the external detector method or EDM (Gleadow, 1981). The EDM has the advantage of allowing fission track ages to be determined on single grains. In apatite, tracks are counted in 20 grains from each mount wherever possible. In those samples where the desired number is not present, all available grains are counted, the actual number depending on the availability of suitably etched and oriented grains. Only grains oriented with surfaces parallel to the crystallographic c-axis are analysed. Such grains can be identified on the basis of the etching characteristics, as well as from morphological evidence in euhedral grains. The grain mount is scanned sequentially, and the first 20 suitably oriented grains identified are analysed.

Tracks are counted within an eyepiece graticule divided into 100 grid squares. In each grain, the number of spontaneous tracks, N_s, within a certain number of grid squares, N_a, is recorded. The number of induced tracks, N_i, in the corresponding location within the mica external detector is then counted. Spontaneous and induced track densities, ρ_s and ρ_i, respectively, are calculated by dividing the track counts by the total area counted, given by the product of Na and the area or each grid square (determined by calibration against a ruled stage graticule or diffraction grating). Fission track ages may be calculated by substituting track counts, N_s and N_i, for track densities ρ_s and ρ_i in equation 1, since the areas cancel in the ratio.

Translation between apatite grains in the grain mount and external detector locations corresponding to each grain is carried out using Autoscan™ microcomputer-controlled automatic stages (Smith and Leigh Jones, 1985). This system allows repeated movement between grain and detector, and all grain locations are stored for later reference if required.

Neutron irradiations are carried out in a well thermalised flux (X-7 facility; Cd ratio for Au ~98) in the Australian Atomic Energy Commission's HIFAR research reactor. Total neutron fluence is monitored by counting tracks in mica external detectors attached to two pieces of NBS standard glass SRM612 included in the irradiation canister at each end of the sample stack. In determining track densities in external detectors irradiated adjacent to uranium standard glasses, 25 fields are normally counted in each detector, and the total track count N_D is divided by the total area counted to obtain the track density ρ_D. The positions of the counted fields are arranged in a 5 X 5 grid covering the whole area of the detector. For typical track densities of between ~5 X 10^5 and 5 X 10^6 this is a convenient arrangement to sample across the detector while gathering sufficient counts to achieve a precision of ~±2% in a reasonable time.

A small flux gradient is often present in the irradiation facility over the length of the sample package (note that this developed only in late 1991, after extended refurbishment of the reactor, before which no detectable flux gradient was present). If a detectable gradient is present, the track count in the external detector adjacent to each standard glass is converted to a track density ρ_D and a value for each mount in the stack is calculated by linear interpolation. When no detectable gradient is present, the track counts in the two external detectors are pooled to give a single value of ρ_D which is used to calculate fission track ages for each sample.

A Zeta calibration factor, ζ, has been determined empirically for each observer by analysing a set of carefully chosen age standards with independently known K-Ar ages, following the methods outlined by Hurford and Green (1983) and Green (1985).

All track counting is carried out using Zeiss(R) Axioplan microscopes, with an overall linear magnification of 1068 x using dry objectives.

For further details and background information on practical aspects of fission track age determination, see e.g. Fleischer, Price and Walker (1975), Naeser (1979) and Hurford (1986).

TRACK-LENGTH MEASUREMENTS

For track length studies in apatite, the full lengths of 'confined' fission tracks are measured. Confined tracks are those which do not intersect the polished surface but have been etched from other tracks or fractures, so that the whole length of the track is etched. Confined track lengths are measured using a digitising tablet connected to a microcomputer, superimposed on the microscope field of view via a projection tube. With this system, calibrated against a stage graticule ruled in 2 μm divisions, individual tracks can be measured to a precision of ± 0.2 μm. Tracks are measured only in prismatic grains, characterised by sharp polishing scratches with well etched tracks of narrow cone angle in all orientations, because of the anisotropy of annealing of fission tracks in apatite (as discussed by Green and others, 1986). Tracks are also measured following the recommendations of Laslett and others (1982), the most important of which is that only horizontal tracks should be measured. One hundred tracks are measured whenever possible. In apatite samples with low track density, or in those samples in which only a small number of apatite grains are obtained, fewer confined tracks may be available, and in such cases, the whole mount is scanned to measure as many confined tracks as possible.

INTEGRATED FISSION-TRACK AGE AND LENGTH MEASUREMENTS

Fission track age determination and length measurement are now made in a single pass of the grain mount, in an integrated approach. The location of each grain in which tracks are either counted or measured is recorded for future reference. Thus track length measurements can be tied to age determination in individual grains. As a routine procedure we do not measure the age of every grain in which lengths are determined, as this would be much too time consuming. Likewise we do not only measure ages in grain in which lengths are measured, as this would bias the age data against low track density grains. Nevertheless, the ability to determine the fission track age of certain grains from which length data originate can be a particularly useful aid to interpretation in some cases. Grain location data are not provided in this report, but are available on request.

PRESENTATION OF FISSION-TRACK AGE DATA

Data sheets summarising the apatite fission track age data, including full details of fission track age data for individual apatite grains in each sample, together with the primary counting results and statistical data, are given in the following pages. Individual grain fission track ages are calculated from the ratio of spontaneous to induced fission track counts for each grain using equation 1, and errors in the single grain ages are calculated using Poissonian statistics, as explained in more detail by Galbraith (1981) and Green (1981). All errors are quoted as $\pm 1\sigma$ throughout this report, unless otherwise stated.

The variability of fission track ages between individual apatite grains within each sample can be assessed using a chi-squared (χ^2) statistic (Galbraith, 1981), the results of which are summarised for each sample in the data sheets. If all the grains counted belong to a single age population, then the probability of obtaining the observed χ^2 value, for ν degrees of freedom (where ν = number of crystals -1), is listed in the data sheets as $P(\chi^2)$ or P(chi squared).

A $P(\chi^2)$ value greater than 5% can be taken as evidence that all grains are consistent with a single population of fission track age. In this case, the best estimate of the fission track age of the sample is given by the "pooled age", calculated from the ratio of the total spontaneous and induced track counts in all grains analysed. Errors for the pooled age are calculated using the 'conventional' technique outlined by Green (1981), based on the total number of tracks counted for each track density measurement (see also Galbraith, 1981).

A $P(\chi^2)$ value of less than 5% denotes a significant spread of single grain ages, and suggests that real differences exist between the fission track ages of individual apatite grains. A significant spread in grain ages can result either from inheritance of detrital grains from mixed source areas (in sedimentary rocks), or from differential annealing in apatite grains of different composition, within a narrow range of temperature.

Calculation of the pooled age inherently assumes that only a single population of ages is present, and is thus not appropriate to samples containing a significant spread of fission track ages. In such cases Galbraith has recently devised a means of estimating the modal age of a distribution of single grain fission track ages which is referred to as the "central age". Calculation of the central age assumes that all single grain ages belong to a Normal distribution of ages with a standard deviation, σ, known as the "age dispersion". An iterative algorithm (Galbraith and Laslett, 1993) is used to provide estimates of the central age with its associated error, and the age dispersion, which are all quoted in the data sheets. Note that this treatment replaces use of the "mean age" which has used been in the past for those samples in which $P(\chi^2)<5\%$. For samples in which $P(\chi^2)>5\%$, the central age and the pooled age should be equal, and the age dispersion should be less than ~10%.

Table 2 summarises the fission track age data in apatite from each sample analysed.

CONSTRUCTION OF RADIAL PLOTS OF SINGLE GRAIN AGE DATA

Single grain age data are best represented in the form of radial plot diagrams (Galbraith, 1988, 1990). As illustrated in Figure 1, these plots display the variation of individual grain ages in a plot of y against x, where:

$$y = (z_j - z_o)/\sigma_i \qquad x = 1/\sigma_j \qquad \text{equation 2}$$

and;

z_j = fission track age of grain j

z_o = a reference age

σ_j = error in age for grain j

In this plot, all points on a straight line from the origin define a single value of fission track age, and at any point the value of x is a measure of the precision of each individual grain age. Therefore, precise individual grain ages fall to the right of the plot (small error, high x), which is useful, for example, in enabling precise, young grains to be identified. The age scale is shown radially around the perimeter of the plot (in Ma). If all grains belong to a single age population, all data should scatter between y = +2 and y = -2, equivalent to scatter within $\pm 2\sigma$. Scatter outside these boundaries shows a significant spread of individual grain ages, as also reflected in the values of $P(\chi^2)$ and age dispersion.

In detail, rather than using the fission track age for each grain as in equation 2, we use:

$$z_j = \frac{N_{sj}}{N_{ij}} \qquad \sigma_j = \{1/N_{sj} + 1/N_{ij}\} \qquad \text{equation 3}$$

as we are interested in displaying the scatter <u>within</u> the data from each sample in comparison with that allowed by the Poissonian uncertainty in track counts, without the additional terms which are involved in determination of the fission track age (ρ_D, ζ, etc).

Zero ages cannot be displayed in such a plot. This can be achieved using a modified plot, (Galbraith, 1990) with:

$$z_j = \arcsin\sqrt{\left\{\frac{N_{sj}+3/8}{N_{sj} + N_{ij} + 3/4}\right\}} \qquad \sigma_j = \frac{1}{2}\sqrt{\left\{\frac{1}{N_{sj} + N_{ij}}\right\}} \qquad \text{eq. 4}$$

Note that the numerical terms in the equation for z_j are standard terms, introduced for statistical reasons. Using this arc-sin transformation, zero ages plot on a diagonal line which slopes from upper left to lower right. Note that this line does not go through the origin. Figure 2 illustrates this difference between conventional and arc-sin radial plots, and also provides a simple guide to the structure of radial plots.

Use of arc-sin radial plots is particularly useful in assessing the relative importance of zero ages. For instance, grains with $N_s = 0$, $N_i = 1$ are compatible with ages up to ~900 Ma (at the 95% confidence level), while grains with $N_s = 0$, $N_i = 50$ are only compatible with ages up to ~14 Ma. The two data would readily be distinguishable on the radial plot as the 0,50 datum would plot well to the right (high x) compared to the 0,1 datum.

In this report the value of z corresponding to the fission track age of each sample is adopted as the reference value, z_o.

Note that the x axis of the radial plot is normally not labelled, as this would obscure the age scale around the plot. In general labelling is not considered necessary, as we are concerned only with relative variation within the data, rather than absolute values of precision.

Radial plots of the single grain age data in apatite from each sample analysed in this report are shown on the fission track age data summary sheets at the end of this report.

HISTOGRAMS OF TRACK-LENGTH DATA

Distributions of confined track lengths in apatite from each sample are shown as simple histograms on the fission track age data summary sheets at the end of this report. For every track length measurement, the length is recorded to the nearest 0.1 μm, but the measurements have been grouped into 1 μm intervals for construction of these histograms. Each distribution has been normalised to 100 tracks for each sample to facilitate comparison. A summary of the length distribution in each sample is presented in Table 3, which also shows the mean track length in each sample and its associated error, the standard deviation of each distribution and the number of tracks (N) measured in each sample. The angle which each confined track makes with the crystallographic c-axis is also routinely recorded, as is the width of each fracture within which tracks are revealed. These data are not provided in this report.

BREAKDOWN OF DATA INTO COMPOSITIONAL GROUPS

Apatite fission-track data are grouped into compositional intervals of 0.1 wt% Cl width. Parameters for each interval represent the data from all grains with Cl contents within each interval. Also shown are the parameters for each compositional interval predicted from the Default Thermal History. These data form the basis of interpretation of the AFTA data, which takes full account of the influence of Cl content on annealing kinetics. Distributions of Cl contents in all apatites analysed from each sample (i.e. for both age and length determinations) are shown on the fission-track age data summary sheets at the end of this report.

PLOTS OF FISSION-TRACK AGE AGAINST Cl CONTENT FOR INDIVIDUAL APATITE GRAINS

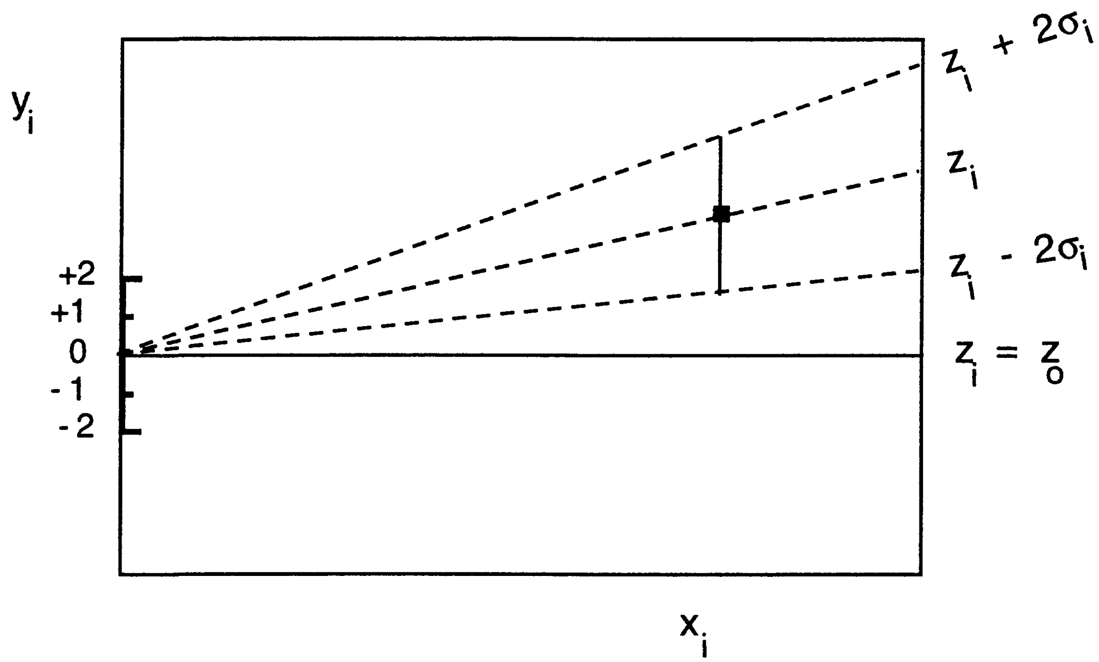
Fission-track ages of single apatite grains within individual samples are plotted against the Cl content of each grain on the fission-track age data summary sheets at the end of this report. These plots are useful in assessing the degree of annealing, as expressed by the fission-track age data. For example, if grains with a range of Cl contents from zero to some upper limit all give similar fission-track ages which are significantly less than the stratigraphic age, then grains with these compositions must have been totally annealed. Alternatively, if fission-track age falls rapidly with decreasing Cl content, the sample displays a high degree of partial annealing.

A NOTE ON TERMINOLOGY

Note that throughout this report, the term "fission-track age" is understood to denote the parameter calculated from the fission-track age equation, using the observed spontaneous and induced track counts (either pooled for all grains or for individual grains). The resulting number (with units of Ma) should not be taken as possessing any significance in terms of events taking place at the time indicated by the measured fission-track age, but should rather be regarded as a measure of the integrated thermal history of the sample, and should be interpreted in that light. Use of the term "apparent age" is not considered to be useful in this regard, as almost every fission-track age should be regarded as an apparent age, in the classic sense, and repeated use becomes cumbersome.

Estimates	z_i
Standard errors	σ_i
Reference value	z_o
Standardised estimates	$y_i = (z_i - z_o) / \sigma_i$
Precision	$x_i = 1 / \sigma_i$

PLOT y_i against x_i



Slope of line from origin through data point $= y_i / x_i$

$= \{(z_i - z_o)/\sigma_i\} / \{1/\sigma_i\}$

$= z_i - z_o$

Key Points:

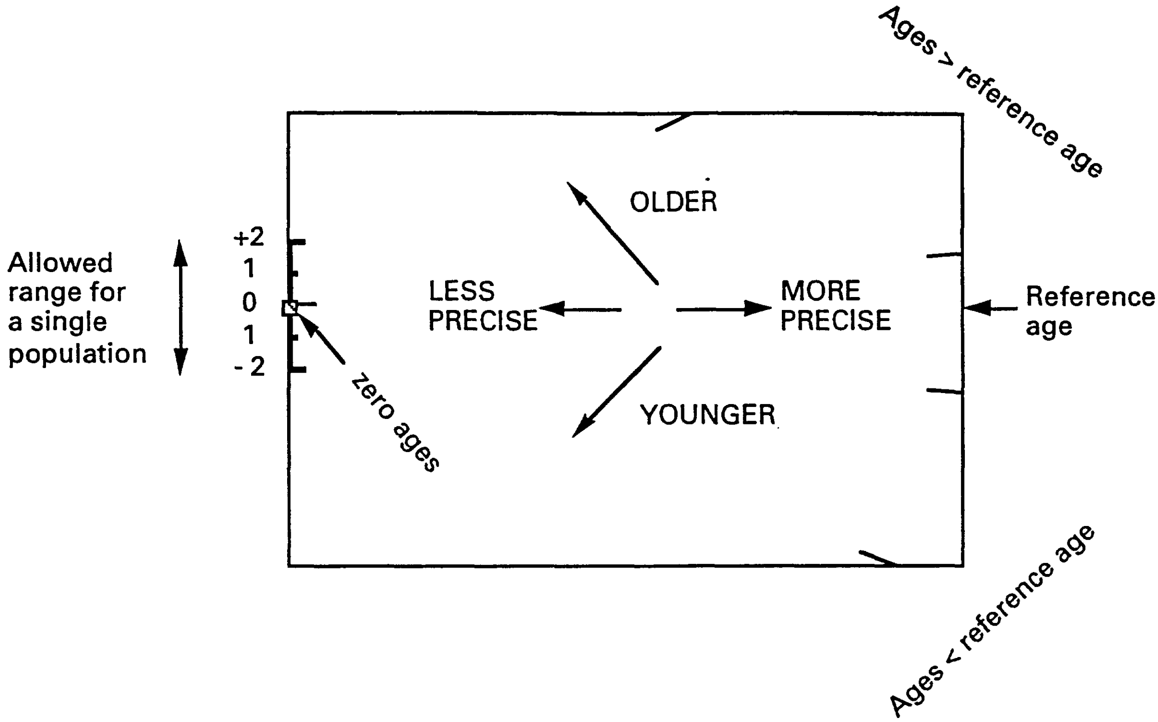
Radial lines emanating from the origin correspond to fixed values of z

Data points with higher values of x_i have greater precision.

Error bars on all points are the same size in this plot.

Figure 1. Basic construction of a radial plot. In AFTA, the estimates z_i correspond to the fission-track age values for individual apatite grains. Any convenient value of age can be chosen as the reference value corresponding to the horizontal in the radial plot. Radial lines emanating from the origin with positive slopes correspond to fission-track ages greater than the reference value. Lines with negative slopes correspond to fission-track ages less than the reference value.

Normal radial plot (equations 2 and 3)



Arc-sin radial plot (equations 2 and 4)

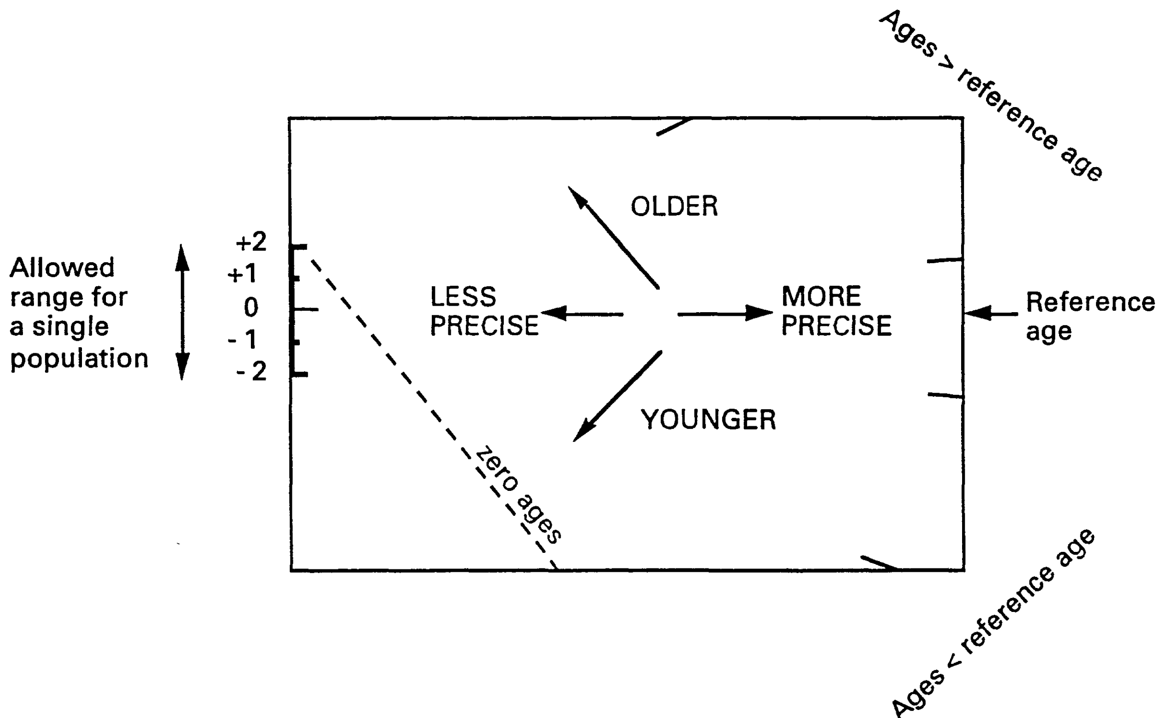


Figure 2 Simplified structure of Normal and Arc-sin radial plots.

Table 1. Fission-track sample numbers, locations, stratigraphic assignment, age, and apatite yields for analyzed samples. Stratigraphic ages from Micropaleo Consultants, Inc.

Sample number	USGS field Number	Location and Elevation (ft)	Stratigraphic Subdivision	Stratigraphic age (Ma)	Raw weight (g)	Washed weight (g)	Apatite yield *1
Outcrop samples							
GC763-36	99TM-503B	Okokmilaga at Akmaktaksrak Bluff 68°37.513' N 153°13.650' W 1640'	Fortress Mtn Fm	115-105	4580	660	excellent
GC763-37	99TM-515B	Siksikpuk Rv at Tiglukpuk Ck 68°31.911' N 152°02.981' W 1500'	Fortress Mtn Fm	115-105	5000	640	excellent
GC763-38	99TM-538	Gunsight Mtn 68°42.820' N 151°52.092' W 450'	Tuktu Fm	110-100	6750	550	excellent
GC763-39	99TM-551B	Okpikruak Rv at Sivogakruak Bluff 68.66894° N 153.45382° W 1542'	Torok Fm	112-105	6070	790	excellent
GC763-40	99TM-564B	Kiruktagiak Rv 68°37.666' N 152°39.349' W 1500'	Fortress Mtn Fm	115-105	6530	590	excellent
GC763-41	99TM-568A	Tiglukpuk Ck 68°25.943' N 151°54.091' W 200'	Okpikruak	141-136	5760	800	excellent
GC763-42	99TM-576B	Pediment Ck 68°42.347' N 153°13.854' W 1345'	Torok Fm	112-105	4210	990	excellent
GC763-43	99TM-578B	junction of Killik - Okokmilaga Rvs 68°55.728' N 153°26.058' W 869'	Chandler Fm	90-84	5450	540	excellent
GC763-44	99DH-52	trib. To E fork, Oolamnagavik Rv 68.78355°N 153.96614°W 1200'	Torok Fm	112-105	9040	1790	excellent
GC763-45	99DH-54	Killik bend, Colville Rv 68.97000°N 153.94053° W 600'	Chandler Fm	90-84	5670	1580	excellent
GC763-46	99DH-65B	Okpikruak Rv at Sivogakruak Bluff 68°40.452' N 153°25.987' W 1476'	Torok Fm	112-105	5240	1390	excellent
GC763-47	99CP-A13	Siksikpuk Rv near Confusion Ck 68°28.060' N 152°05.216' W 2000'	Okpikruak Fm	141-136	2870	880	excellent

*1 Yield based on quantity of mineral suitable for age determination. Excellent: >20 grains; Good: 15-19 grains; Fair: 10-14 grains; Poor: 5-9 grains; Very Poor: <5 grains.

Table 2. Apatite fission-track analytical results.

Sample number	Number of grains	ρ_D (N_D) $\times 10^6/cm^2$	ρ_s (N_s) $\times 10^6/cm^2$	ρ_i (N_i) $\times 10^6/cm^2$	Uranium content (ppm)	$P(\chi^2)$ (%)	Age dispersion (%)	Fission track age (Ma)
Outcrop samples								
GC763-36	27	1.397	0.569	2.367	19	90	<1	63.9 ± 4.0
		(2253)	(383)	(1594)				
GC763-37	25	1.403	0.459	2.104	17	<1	36	58.3 ± 3.2
		(2253)	(513)	(2350)				*58.9 ± 5.9**
GC763-38	34	1.409	0.497	1.955	16	1	30	68.1 ± 4.0
		(2253)	(439)	(1727)				*64.8 ± 6.1**
GC763-39	25	1.415	0.437	1.764	14	5	18	66.6 ± 4.3
		(2253)	(355)	(1434)				*69.1 ± 5.6**
GC763-40	29	1.420	0.553	1.736	14	<1	27	85.9 ± 4.6
		(2253)	(580)	(1821)				*86.1 ± 7.6**
GC763-41	31	1.426	0.397	1.776	14	<1	31	60.6 ± 3.7
		(2253)	(389)	(1742)				*64.2 ± 6.1**
GC763-42	23	1.432	0.621	2.592	21	65	2	65.3 ± 4.9
		(2253)	(244)	(1018)				
GC763-43	26	1.438	0.395	1.059	8	<1	46	101.7 ± 7.0
		(2253)	(331)	(888)				*89.8 ± 13.6**
GC763-44	25	1.444	0.711	2.539	20	<1	36	76.8 ± 4.7
		(2253)	(408)	(1457)				*75.9 ± 8.1**
GC763-45	20	1.450	0.061	0.402	3	1	124	41.6 ± 7.5
		(2253)	(36)	(239)				*33.2 ± 12.9**
GC763-46	25	1.455	0.656	2.433	19	<1	40	74.6 ± 4.6
		(2253)	(409)	(1517)				*91.2 ± 10.4**
GC763-47	29	1.461	0.336	1.527	12	3	26	61.2 ± 4.0
		(2253)	(328)	(1491)				*60.2 ± 5.3**

ρ_s = spontaneous track density; ρ_i = induced track density; ρ_D = track density in glass standard external detector. Brackets show number of tracks counted. ρ_D and ρ_i measured in mica external detectors; ρ_s measured in internal surfaces.
*Central age, used where sample contains a significant spread of single grain ages ($P(\chi^2)<5\%$). Errors quoted at 1σ.
Ages calculated using dosimeter glass CN5, with a zeta of 382.4 ± 5.5 (Analyst: S. Marshallsea) for samples: 36 - 47

Table 3. Length distribution summary data.

Sample number	Mean track length (μm)	Standard deviation (μm)	Number of tracks (N)	Number of tracks in Length Intervals (μm)																			
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Outcrop samples																							
GC763-36	13.59 ± 0.18	1.69	85	-	-	-	-	-	-	-	2	2	3	7	12	18	22	17	2	-	-	-	-
GC763-37	13.36 ± 0.22	2.16	100	-	-	-	-	1	1	-	2	-	4	1	7	17	31	16	11	6	3	-	-
GC763-38	12.78 ± 1.93	1.93	22	-	-	-	-	-	-	-	-	1	-	1	3	3	5	8	-	1	-	-	-
GC763-39	13.70 ± 0.26	1.99	58	-	-	-	-	-	-	-	-	1	2	3	5	7	12	10	11	7	-	-	-
GC763-40	14.37 ± 0.21	1.46	48	-	-	-	-	-	-	-	-	-	-	1	2	6	11	9	13	6	-	-	-
GC763-41	13.88 ± 0.18	1.84	108	-	-	-	-	-	-	-	-	1	6	2	8	11	21	28	22	9	-	-	-
GC763-42	13.50 ± 0.24	2.21	85	-	-	1	1	-	-	-	-	-	1	2	7	9	24	25	10	5	-	-	-
GC763-43	13.21 ± 0.40	2.25	32	-	-	-	-	-	-	-	-	-	4	4	-	4	6	6	6	2	-	-	-
GC763-44	13.80 ± 0.21	2.08	101	-	-	-	-	1	-	-	1	3	2	1	6	6	22	35	16	7	1	-	-
GC763-45	No confined	tracks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GC763-46	13.39 ± 0.22	2.03	84	-	-	-	1	-	-	-	1	-	2	7	4	11	19	25	12	1	1	-	-
GC763-47	14.26 ± 0.19	1.67	77	-	-	-	-	-	-	-	-	-	-	2	9	7	9	22	17	11	-	-	-

Track length measurements by: S. Marshallsea for samples; 36 - 47

EXPLANATION FOR FISSION-TRACK DATA SHEETS

Ns =	Number of spontaneous tracks in Na grid squares
Ni =	Number of induced tracks in Na grid squares
Na =	Number of grid squares counted in each grain
RATIO =	Ns/Ni
U (ppm) =	Uranium content of each grain (= U content of standard glass * $\rho i/\rho_D$)
Cl (wt%) =	Weight percent chlorine content of each grain
RHOs =	Spontaneous track density (ρs) = Ns/ (Na*area of basic unit)
RHOi =	Induced track density (ρi) = Ni/(Na*area of basic unit)
F.T. AGE =	Fission-track age, calculated using equation 1
Area of basic unit =	Area of one microscope eyepiece grid square
Chi squared =	χ^2 parameter, used to assess variation of single grain ages within the sample
P(chi squared) =	Probability of obtaining observed χ^2 value for the relevant number of degrees of freedom, if all grains belong to a single population
Age Dispersion =	% variation in single grain ages - see discussion in text re "Central age"
Ns/Ni =	Pooled ratio, total spontaneous tracks divided by total induced tracks for all grains
Mean ratio =	Mean of (Ns/Ni) for individual grains
Zeta =	Calibration constant, determined empirically for each observer
RhoD =	Track density (ρ_D) from uranium standard glass (interpolated from values at each end of stack)
ND =	Total number of tracks counted for determining ρ_D
POOLED AGE =	Fission-track age calculated from pooled ratio Ns/Ni. Valid only when $\chi^2 > 5\%$
CENTRAL AGE =	Alternative to pooled age when $\chi^2 < 5\%$

Organization and captions for graphical plots shown in data sheets:

Plot A: Radial plot of single grain ages for analyzed sample. *(See Figures 1 and 2 for details of radial plot construction)*	Plot B: Distribution of Cl contents in apatite grains for analyzed sample.
Plot C: Single grain age vs weight % Cl for individual apatite grains in analyzed sample	Plot D: Distribution of confined track lengths in analyzed sample.

GC763-36 APATITE
IRRADIATION G820
SLIDE NUMBER 1
COUNTED-BY: SJM

USGS Sample 99TM-503

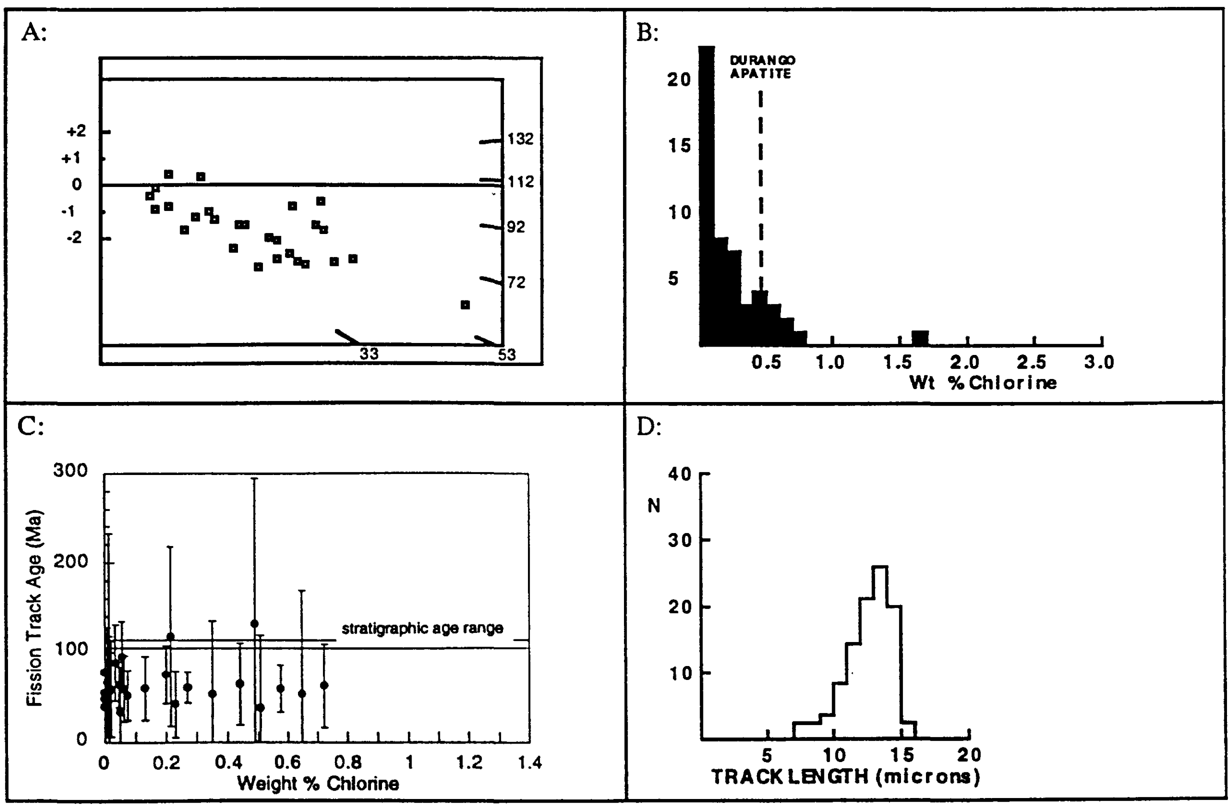
Current grain no.	Ns	Ni	Na	RHOs	RHOi	RATIO	U (ppm)	Cl (wt%)	F.T. AGE (Ma)
3	12	66	42	4.540E+05	2.497E+06	0.182	20.4	0.00	48.4 ± 15.2
4	13	58	24	8.607E+05	3.840E+06	0.224	31.3	0.06	59.6 ± 18.4
12	2	16	42	7.567E+04	6.054E+05	0.125	4.9	0.05	33.3 ± 25.0
13	32	89	20	2.542E+06	7.071E+06	0.360	57.7	0.06	95.3 ± 19.8
15	1	7	44	3.612E+04	2.528E+05	0.143	2.1	0.51	38.1 ± 40.7
18	8	18	20	6.356E+05	1.430E+06	0.444	11.7	0.21	117.7 ± 50.1
21	10	41	60	2.648E+05	1.086E+06	0.244	8.9	0.44	64.8 ± 22.9
22	4	19	28	2.270E+05	1.078E+06	0.211	8.8	0.02	56.0 ± 30.8
25	2	6	24	1.324E+05	3.973E+05	0.333	3.2	0.02	88.4 ± 72.2
29	6	27	16	5.959E+05	2.682E+06	0.222	21.9	0.02	59.1 ± 26.7
30	14	62	20	1.112E+06	4.926E+06	0.226	40.2	0.13	60.0 ± 17.8
31	2	10	32	9.932E+04	4.966E+05	0.200	4.1	0.35	53.2 ± 41.2
32	9	38	32	4.469E+05	1.887E+06	0.237	15.4	0.72	63.0 ± 23.4
33	26	89	48	8.607E+05	2.946E+06	0.292	24.0	0.00	77.6 ± 17.4
34	6	38	19	5.018E+05	3.178E+06	0.158	25.9	0.23	42.0 ± 18.5
37	8	54	50	2.542E+05	1.716E+06	0.148	14.0	0.00	39.5 ± 15.0
39	17	87	50	5.403E+05	2.765E+06	0.195	22.6	0.07	52.0 ± 13.8
41	31	129	40	1.232E+06	5.125E+06	0.240	41.8	0.05	63.9 ± 12.9
43	15	73	70	3.405E+05	1.657E+06	0.205	13.5	0.00	54.7 ± 15.6
44	4	8	50	1.271E+05	2.542E+05	0.500	2.1	0.49	132.2 ± 81.0
48	1	5	30	5.297E+04	2.648E+05	0.200	2.2	0.65	53.2 ± 58.3
49	25	112	40	9.932E+05	4.449E+06	0.223	36.3	0.57	59.4 ± 13.2
52	23	69	48	7.614E+05	2.284E+06	0.333	18.6	0.04	88.4 ± 21.4
53	28	98	80	5.562E+05	1.947E+06	0.286	15.9	0.20	75.9 ± 16.4
62	62	270	30	3.284E+06	1.430E+07	0.230	116.7	0.27	61.1 ± 8.7
73	16	81	63	4.036E+05	2.043E+06	0.198	16.7	0.01	52.6 ± 14.4
79	6	24	48	1.986E+05	7.945E+05	0.250	6.5	0.01	66.4 ± 30.4
	383	1594		5.688E+05	2.367E+06		19.3		

Area of basic unit = 6.293E-07 cm-2

Chi Squared = 17.322 with 26 degrees of freedom
P(chi squared) = 89.9 %
Age Dispersion = 0.295 % (did not converge)
Ns/Ni = 0.240 ± 0.014
Mean Ratio = 0.245 ± 0.017

Ages calculated using a zeta of 382.4 ± 5.5 for CN5 glass
Rho D = 1.397E+06cm-2; ND = 2253
Rho D interpolated between top of can; Rho D = 1.397E+06cm-2, ND = 1099
bottom of can; Rho D = 1.467E+06cm-2, ND = 1154

POOLED AGE = 63.9 ± 4.0 Ma
CENTRAL AGE = 63.9 ± 4.0 Ma



IRRADIATION G820
SLIDE NUMBER 2
COUNTED BY: SJM

USGS Sample 99TM-515B

Current grain no.	Ns	Ni	Na	RHOs	RHOi	RATIO	U (ppm)	Cl (wt%)	F.T. AGE (Ma)
4	14	26	100	2.225E+05	4.132E+05	0.538	3.4	1.05	142.9 ± 47.5
5	4	6	50	1.271E+05	1.907E+05	0.667	1.5	1.24	176.4 ± 114.0
6	3	18	90	5.297E+04	3.178E+05	0.167	2.6	0.28	44.6 ± 27.8
8	5	51	39	2.037E+05	2.078E+06	0.098	16.9	0.01	26.2 ± 12.3
9	1	13	56	2.838E+04	3.689E+05	0.077	3.0	0.00	20.6 ± 21.4
10	48	209	64	1.192E+06	5.189E+06	0.230	42.2	0.03	61.3 ± 9.9
11	3	25	70	6.810E+04	5.675E+05	0.120	4.6	0.26	32.1 ± 19.6
12	21	61	42	7.945E+05	2.308E+06	0.344	18.8	0.00	91.7 ± 23.3
13	4	15	70	9.080E+04	3.405E+05	0.267	2.8	0.02	71.1 ± 40.1
14	6	75	74	1.288E+05	1.611E+06	0.080	13.1	0.00	21.4 ± 9.1
15	12	94	67	2.846E+05	2.229E+06	0.128	18.1	0.14	34.2 ± 10.5
16	34	65	70	7.718E+05	1.476E+06	0.523	12.0	1.04	138.8 ± 29.6
17	6	13	100	9.534E+04	2.066E+05	0.462	1.7	0.50	122.6 ± 60.6
19	21	89	49	6.810E+05	2.886E+06	0.236	23.5	0.03	63.0 ± 15.4
21	25	136	84	4.729E+05	2.573E+06	0.184	20.9	0.06	49.1 ± 10.8
22	6	43	80	1.192E+05	8.541E+05	0.140	6.9	0.50	37.3 ± 16.3
23	2	9	80	3.973E+04	1.788E+05	0.222	1.5	0.67	59.3 ± 46.4
28	66	321	90	1.165E+06	5.668E+06	0.206	46.1	0.06	54.9 ± 7.6
31	5	59	100	7.945E+04	9.375E+05	0.085	7.6	0.06	22.7 ± 10.6
36	84	369	50	2.670E+06	1.173E+07	0.228	95.3	0.77	60.8 ± 7.5
44	51	207	70	1.158E+06	4.699E+06	0.246	38.2	0.09	65.8 ± 10.4
48	18	59	100	2.860E+05	9.375E+05	0.305	7.6	0.57	81.3 ± 22.0
54	5	36	80	9.932E+04	7.151E+05	0.139	5.8	0.05	37.2 ± 17.8
57	18	73	40	7.151E+05	2.900E+06	0.247	23.6	0.07	65.8 ± 17.4
58	51	278	60	1.351E+06	7.363E+06	0.183	59.8	0.30	49.0 ± 7.6
	513	2350		4.593E+05	2.104E+06		17.1		

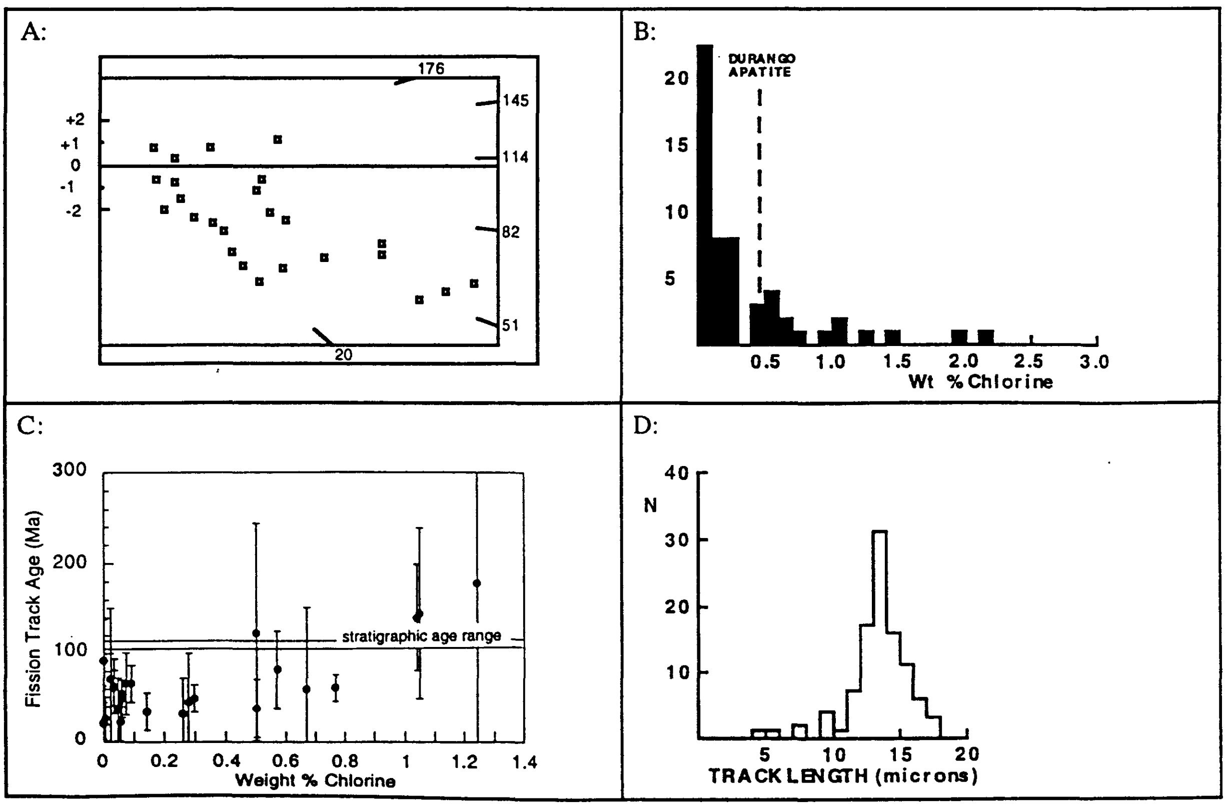
Area of basic unit = 6.293E-07 cm-2

Chi Squared = 61.083 with 24 degrees of freedom
P(chi squared) = 0.0 %
Age Dispersion = 35.928 %

Ns/Ni = 0.218 ± 0.011
Mean Ratio = 0.245 ± 0.031

Ages calculated using a zeta of 382.4 ± 5.5 for CN5 glass
Rho D = 1.403E+06cm-2; ND = 2253
Rho D interpolated between top of can; Rho D = 1.397E+06cm-2, ND = 1099
bottom of can; Rho D = 1.467E+06cm-2, ND = 1154

POOLED AGE = 58.3 ± 3.2 Ma
CENTRAL AGE = 58.9 ± 5.9 Ma



USGS Sample 99TM-538

GC763-38 APATITE 99TM-538

IRRADIATION G820
SLIDE NUMBER 3
COUNTED BY: SJM

Current grain no.	Ns	Ni	Na	RHOs	RHOi	RATIO	U (ppm)	Cl (wt%)	F.T. AGE (Ma)
4	2	5	31	1.025E+05	2.563E+05	0.400	2.1	0.00	106.9 ± 89.4
5	0	3	56	0.000E+00	8.513E+04	0.000	0.7	0.00	0.0 ± 0.0
7	2	13	24	1.324E+05	8.607E+05	0.154	7.0	0.07	41.3 ± 31.4
9	0	2	30	0.000E+00	1.059E+05	0.000	0.9	0.00	0.0 ± 0.0
10	0	3	15	0.000E+00	3.178E+05	0.000	2.6	0.00	0.0 ± 0.0
11	0	2	50	0.000E+00	6.356E+04	0.000	0.5	0.00	0.0 ± 0.0
12	6	17	14	6.810E+05	1.930E+06	0.353	15.6	0.02	94.4 ± 44.9
13	7	20	20	5.562E+05	1.589E+06	0.350	12.9	0.03	93.6 ± 41.2
14	1	3	40	3.973E+04	1.192E+05	0.333	1.0	0.00	89.2 ± 103.0
17	0	4	70	0.000E+00	9.080E+04	0.000	0.7	0.00	0.0 ± 0.0
18	0	3	70	0.000E+00	6.810E+04	0.000	0.6	0.00	0.0 ± 0.0
20	1	3	100	1.589E+04	4.767E+04	0.333	0.4	0.00	89.2 ± 103.0
21	0	3	80	0.000E+00	5.959E+04	0.000	0.5	0.00	0.0 ± 0.0
22	7	27	18	6.180E+05	2.384E+06	0.259	19.3	0.12	69.5 ± 29.5
25	3	9	18	2.648E+05	7.945E+05	0.333	6.4	0.30	89.2 ± 59.5
29	5	20	34	2.337E+05	9.347E+05	0.250	7.6	0.02	67.0 ± 33.5
30	4	31	80	7.945E+04	6.158E+05	0.129	5.0	0.32	34.7 ± 18.4
31	0	2	24	0.000E+00	1.324E+05	0.000	1.1	0.00	0.0 ± 0.0
32	8	43	24	5.297E+05	2.847E+06	0.186	23.0	0.03	49.9 ± 19.3
35	36	116	28	2.043E+06	6.583E+06	0.310	53.3	0.15	83.1 ± 16.0
37	6	26	70	1.362E+05	5.902E+05	0.231	4.8	0.41	61.9 ± 28.1
38	74	337	71	1.656E+06	7.542E+06	0.220	61.0	0.01	58.9 ± 7.7
39	25	117	28	1.419E+06	6.640E+06	0.214	53.7	0.07	57.3 ± 12.7
40	84	207	28	4.767E+06	1.175E+07	0.406	95.1	0.25	108.4 ± 14.3
41	10	139	80	1.986E+05	2.761E+06	0.072	22.3	0.01	19.4 ± 6.4
42	0	1	72	0.000E+00	2.207E+04	0.000	0.2	0.00	0.0 ± 0.0
51	20	59	24	1.324E+06	3.906E+06	0.339	31.6	0.03	90.7 ± 23.6
53	38	122	28	2.157E+06	6.924E+06	0.311	56.0	0.17	83.4 ± 15.6
43	24	89	25	1.526E+06	5.657E+06	0.270	45.8	0.12	72.2 ± 16.7
46	3	12	36	1.324E+05	5.297E+05	0.250	4.3	0.32	67.0 ± 43.3
47	29	79	42	1.097E+06	2.989E+06	0.367	24.2	0.12	98.1 ± 21.5
48	4	44	25	2.542E+05	2.797E+06	0.091	22.6	0.14	24.4 ± 12.8
50	31	110	21	2.346E+06	8.324E+06	0.282	67.4	0.07	75.5 ± 15.5
58	9	56	28	5.108E+05	3.178E+06	0.161	25.7	0.13	43.1 ± 15.5
	439	1727		4.969E+05	1.955E+06		15.8		

Area of basic unit = 6.293E-07 cm-2

Chi Squared = 55.127 with 33 degrees of freedom
P(chi squared) = 0.9 %
Age Dispersion = 29.717 %

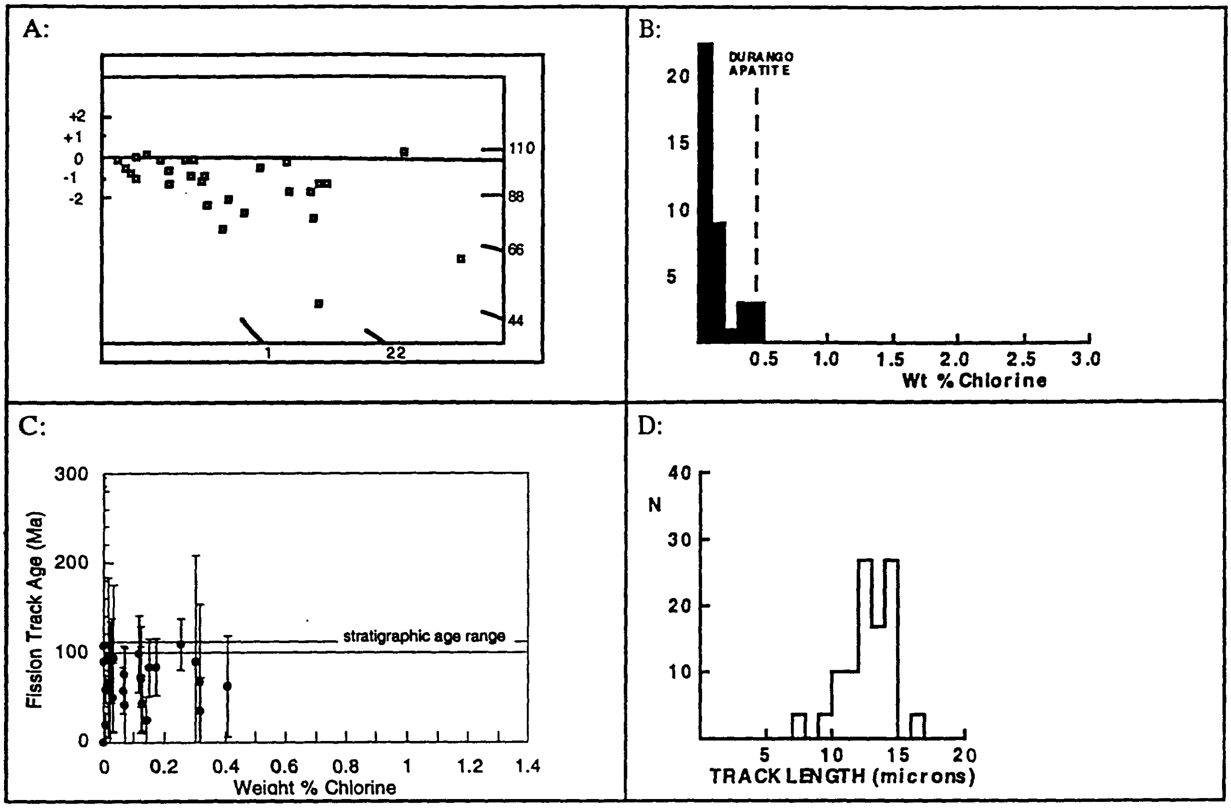
Ns/Ni = 0.254 ± 0.014
Mean Ratio = 0.194 ± 0.024

Ages calculated using a zeta of 382.4 ± 5.5 for CN5 glass
Rho D = 1.409E+06cm-2; ND = 2253
Rho D interpolated between top of can; Rho D = 1.397E+06cm-2, ND = 1099
bottom of can; Rho D = 1.467E+06cm-2, ND = 1154

POOLED AGE = 68.1 ± 4.0 Ma
CENTRAL AGE = 64.8 ± 6.1 Ma

USGS Sample 99TM-538 (continued)

GC763-38 APATITE CONTINUED 99TM-538



USGS Sample 99TM-551B

IRRADIATION G820
SLIDE NUMBER 4
COUNTED BY: SJM

Current grain no.	Ns	Ni	Na	RHOs	RHOi	RATIO	U (ppm)	Cl (wt%)	F.T. AGE (Ma)
3	1	8	42	3.783E+04	3.027E+05	0.125	2.4	0.00	33.7 ± 35.8
5	2	18	16	1.986E+05	1.788E+06	0.111	14.4	0.00	30.0 ± 22.4
6	2	10	49	6.486E+04	3.243E+05	0.200	2.6	0.34	53.9 ± 41.8
7	11	28	20	8.740E+05	2.225E+06	0.393	17.9	0.01	105.4 ± 37.6
9	5	6	42	1.892E+05	2.270E+05	0.833	1.8	0.34	221.6 ± 134.3
10	0	4	50	0.000E+00	1.271E+05	0.000	1.0	0.00	0.0 ± 0.0
11	3	15	56	8.513E+04	4.256E+05	0.200	3.4	0.36	53.9 ± 34.1
12	16	49	50	5.085E+05	1.557E+06	0.327	12.5	0.18	87.7 ± 25.4
13	5	8	20	3.973E+05	6.356E+05	0.625	5.1	0.11	166.9 ± 95.2
14	2	5	80	3.973E+04	9.932E+04	0.400	0.8	0.11	107.3 ± 89.8
16	49	249	80	9.733E+05	4.946E+06	0.197	39.9	0.08	53.0 ± 8.4
17	30	112	36	1.324E+06	4.944E+06	0.268	39.8	0.07	72.0 ± 14.9
19	11	20	80	2.185E+05	3.973E+05	0.550	3.2	1.19	147.1 ± 55.3
20	3	15	80	5.959E+04	2.980E+05	0.200	2.4	0.01	53.9 ± 34.1
21	8	16	49	2.594E+05	5.189E+05	0.500	4.2	0.00	133.8 ± 58.1
22	13	71	90	2.295E+05	1.254E+06	0.183	10.1	0.09	49.3 ± 14.9
23	23	101	84	4.351E+05	1.911E+06	0.228	15.4	0.05	61.3 ± 14.2
25	2	11	24	1.324E+05	7.283E+05	0.182	5.9	0.10	49.0 ± 37.7
27	4	6	20	3.178E+05	4.767E+05	0.667	3.8	0.70	177.9 ± 114.9
28	18	65	54	5.297E+05	1.913E+06	0.277	15.4	0.12	74.5 ± 19.9
31	11	51	32	5.462E+05	2.533E+06	0.216	20.4	0.04	58.1 ± 19.4
35	27	187	80	5.363E+05	3.714E+06	0.144	29.9	0.01	38.9 ± 8.1
63	65	229	56	1.844E+06	6.498E+06	0.284	52.4	0.04	76.3 ± 10.9
37	34	108	42	1.286E+06	4.086E+06	0.315	32.9	0.15	84.6 ± 16.8
38	10	42	60	2.648E+05	1.112E+06	0.238	9.0	0.48	64.1 ± 22.6
	355	1434		4.366E+05	1.764E+06		14.2		

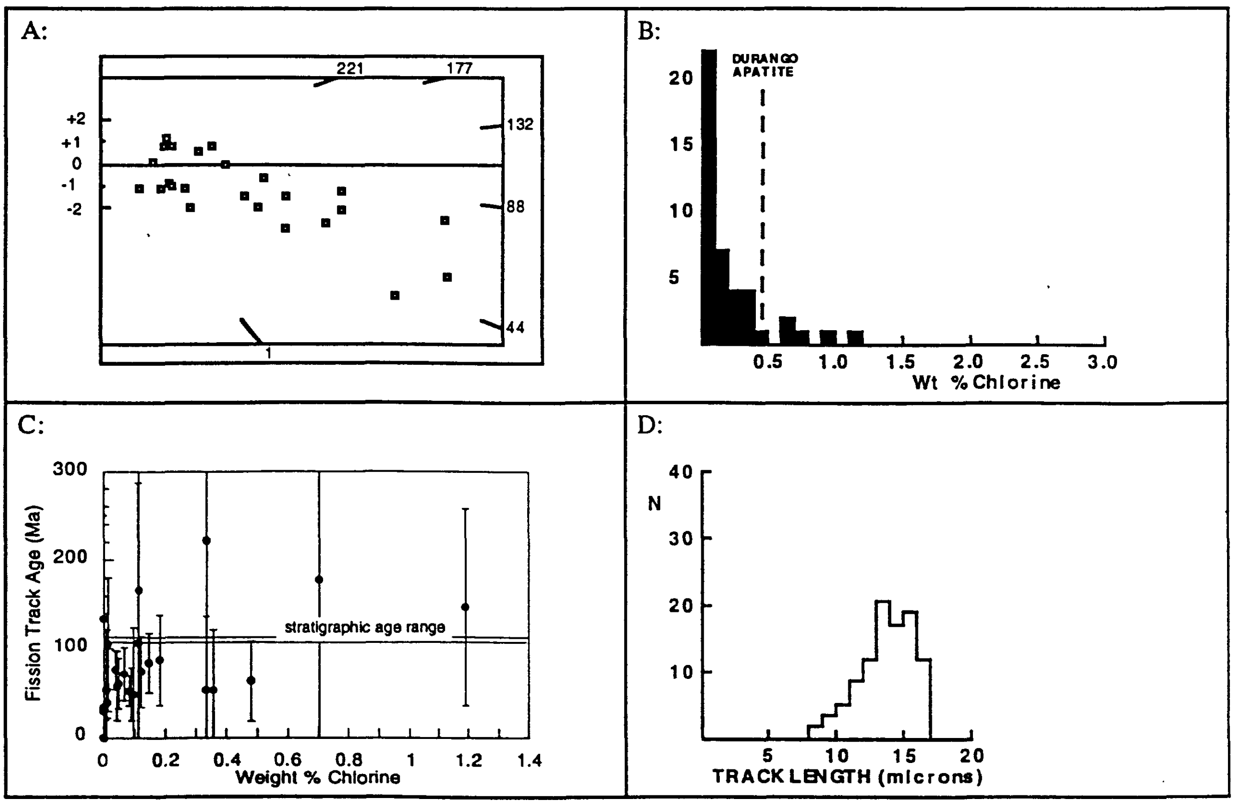
Area of basic unit = 6.293E-07 cm-2

Chi Squared = 36.813 with 24 degrees of freedom
P(chi squared) = 4.6 %
Age Dispersion = 17.626 %

Ns/Ni = 0.248 ± 0.015
Mean Ratio = 0.306 ± 0.039

Ages calculated using a zeta of 382.4 ± 5.5 for CN5 glass
Rho D = 1.415E+06cm-2; ND = 2253
Rho D interpolated between top of can; Rho D = 1.397E+06cm-2, ND = 1099
bottom of can; Rho D = 1.467E+06cm-2, ND = 1154

POOLED AGE = 66.6 ± 4.3 Ma
CENTRAL AGE = 69.1 ± 5.6 Ma



GC763-40 APATITE
IRRADIATION G820
SLIDE NUMBER 5
COUNTED BY: SJM

USGS Sample 99TM-564B

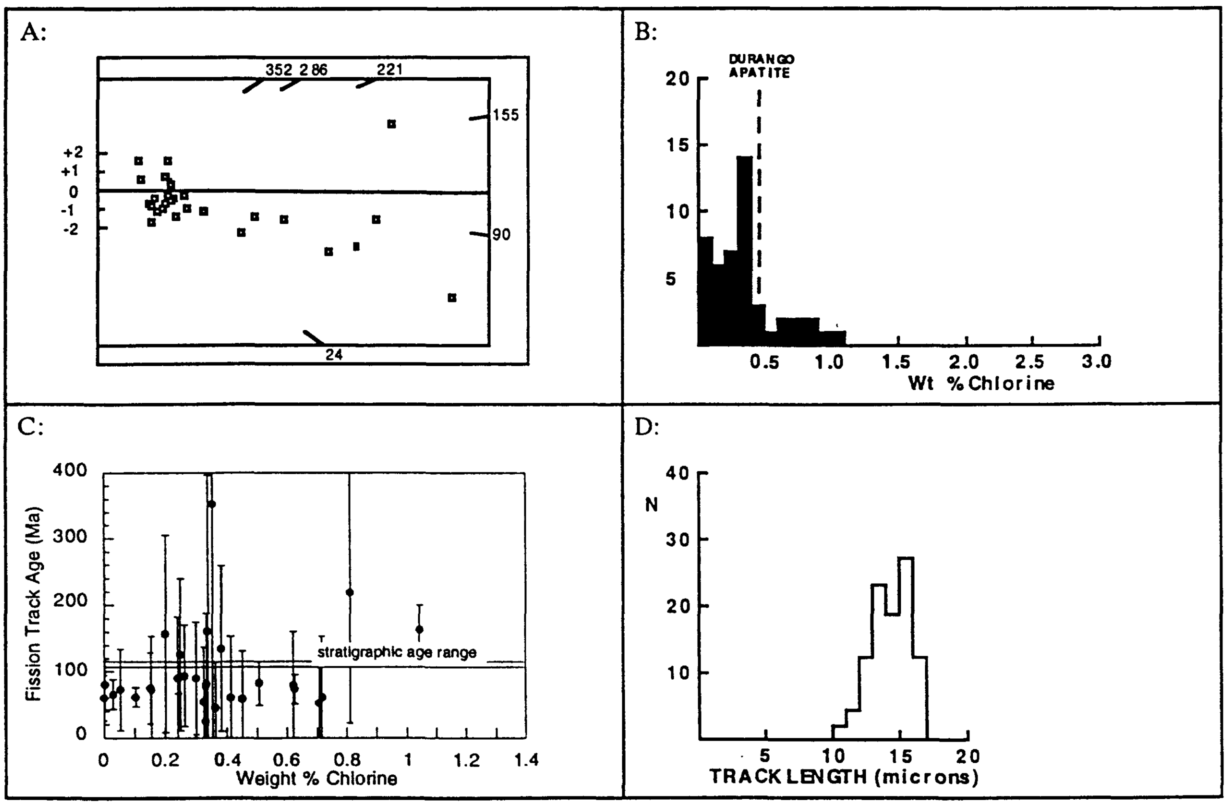
Current grain no.	Ns	Ni	Na	RHOs	RHOi	RATIO	U (ppm)	Cl (wt%)	F.T. AGE (Ma)
3	9	11	49	2.919E+05	3.567E+05	0.818	2.9	0.81	218.5 ± 98.4
4	2	9	70	4.540E+04	2.043E+05	0.222	1.6	0.41	60.1 ± 47.0
5	5	15	90	8.828E+04	2.648E+05	0.333	2.1	0.24	89.9 ± 46.5
6	4	21	84	7.567E+04	3.973E+05	0.190	3.2	0.71	51.5 ± 28.1
7	7	14	78	1.426E+05	2.852E+05	0.500	2.3	0.38	134.4 ± 62.3
8	1	11	56	2.838E+04	3.121E+05	0.091	2.5	0.33	24.6 ± 25.7
9	3	5	40	1.192E+05	1.986E+05	0.600	1.6	0.34	160.9 ± 117.6
10	2	12	80	3.973E+04	2.384E+05	0.167	1.9	0.36	45.1 ± 34.5
11	3	10	60	7.945E+04	2.648E+05	0.300	2.1	0.33	81.0 ± 53.3
14	2	9	40	7.945E+04	3.575E+05	0.222	2.9	0.72	60.1 ± 47.0
15	3	14	56	8.513E+04	3.973E+05	0.214	3.2	0.45	57.9 ± 36.9
17	4	15	36	1.766E+05	6.621E+05	0.267	5.3	0.16	72.0 ± 40.6
18	15	68	20	1.192E+06	5.403E+06	0.221	43.4	0.00	59.6 ± 17.1
20	2	10	60	5.297E+04	2.648E+05	0.200	2.1	0.33	54.1 ± 41.9
23	6	18	64	1.490E+05	4.469E+05	0.333	3.6	0.30	89.9 ± 42.4
26	4	3	35	1.816E+05	1.362E+05	1.333	1.1	0.35	352.3 ± 269.3
27	8	23	60	2.119E+05	6.091E+05	0.348	4.9	0.26	93.8 ± 38.6
28	5	17	81	9.809E+04	3.335E+05	0.294	2.7	0.62	79.4 ± 40.4
29	7	15	49	2.270E+05	4.864E+05	0.467	3.9	0.25	125.5 ± 57.5
33	7	26	60	1.854E+05	6.886E+05	0.269	5.5	0.05	72.7 ± 31.0
38	10	36	26	6.112E+05	2.200E+06	0.278	17.7	0.15	75.0 ± 26.9
41	7	12	45	2.472E+05	4.238E+05	0.583	3.4	0.20	156.5 ± 74.5
43	23	77	32	1.142E+06	3.824E+06	0.299	30.7	0.00	80.6 ± 19.3
45	133	219	58	3.644E+06	6.000E+06	0.607	48.2	1.04	162.9 ± 18.4
51	42	174	56	1.192E+06	4.937E+06	0.241	39.6	0.03	65.2 ± 11.3
53	33	108	100	5.244E+05	1.716E+06	0.306	13.8	0.51	82.5 ± 16.5
55	95	417	60	2.516E+06	1.104E+07	0.228	88.6	0.10	61.6 ± 7.2
61	58	214	80	1.152E+06	4.251E+06	0.271	34.1	0.63	73.2 ± 11.0
62	80	238	42	3.027E+06	9.005E+06	0.336	72.3	0.24	90.7 ± 11.9
	580	1821		5.529E+05	1.736E+06		13.9		

Area of basic unit = 6.293E-07 cm-2

Chi Squared = 68.223 with 28 degrees of freedom
P(chi squared) = 0.0 %
Age Dispersion = 26.695 %
Ns/Ni = 0.318 ± 0.015
Mean Ratio = 0.363 ± 0.045

Ages calculated using a zeta of 382.4 ± 5.5 for CN5 glass
Rho D = 1.420E+06cm-2; ND = 2253
Rho D interpolated between top of can; Rho D = 1.397E+06cm-2, ND = 1099
bottom of can; Rho D = 1.467E+06cm-2, ND = 1154

POOLED AGE = 85.9 ± 4.6 Ma
CENTRAL AGE = 86.1 ± 7.6 Ma



USGS Sample 99TM-568A

GC763-41 APATITE 99TM-568A

IRRADIATION G820
SLIDE NUMBER 6
COUNTED BY: SJM

Current grain no.	Ns	Ni	Na	RHOs	RHOi	RATIO	U (ppm)	Cl (wt%)	F.T. AGE (Ma)
5	3	16	60	7.945E+04	4.238E+05	0.188	3.4	0.34	50.9 ± 32.1
6	6	83	28	3.405E+05	4.710E+06	0.072	37.6	0.01	19.7 ± 8.3
7	7	71	24	4.635E+05	4.701E+06	0.099	37.6	0.19	26.8 ± 10.7
8	5	29	36	2.207E+05	1.280E+06	0.172	10.2	0.10	46.9 ± 22.7
10	2	4	24	1.324E+05	2.648E+05	0.500	2.1	0.70	134.9 ± 116.9
11	3	29	40	1.192E+05	1.152E+06	0.103	9.2	0.04	28.2 ± 17.1
12	2	8	80	3.973E+04	1.589E+05	0.250	1.3	0.27	67.8 ± 53.6
13	2	10	64	4.966E+04	2.483E+05	0.200	2.0	0.25	54.3 ± 42.1
17	22	80	80	4.370E+05	1.589E+06	0.275	12.7	1.07	74.6 ± 18.0
18	0	26	42	0.000E+00	9.837E+05	0.000	7.9	0.01	0.0 ± 0.0
21	6	20	70	1.362E+05	4.540E+05	0.300	3.6	1.18	81.3 ± 37.9
22	2	4	35	9.080E+04	1.816E+05	0.500	1.5	0.41	134.9 ± 116.9
28	16	51	16	1.589E+06	5.065E+06	0.314	40.5	0.24	85.0 ± 24.5
29	1	18	70	2.270E+04	4.086E+05	0.056	3.3	0.79	15.1 ± 15.6
30	0	6	20	0.000E+00	4.767E+05	0.000	3.8	0.53	0.0 ± 0.0
31	1	2	15	1.059E+05	2.119E+05	0.500	1.7	0.35	134.9 ± 165.3
34	4	11	60	1.059E+05	2.913E+05	0.364	2.3	0.33	98.4 ± 57.5
35	13	53	70	2.951E+05	1.203E+06	0.245	9.6	1.06	66.6 ± 20.7
39	18	36	21	1.362E+06	2.724E+06	0.500	21.8	0.30	134.9 ± 39.1
46	127	636	100	2.018E+06	1.011E+07	0.200	80.8	0.11	54.2 ± 5.4
47	5	4	80	9.932E+04	7.945E+04	1.250	0.6	0.35	332.2 ± 223.0
52	10	38	40	3.973E+05	1.510E+06	0.263	12.1	1.16	71.4 ± 25.4
54	3	16	100	4.767E+04	2.542E+05	0.188	2.0	0.49	50.9 ± 32.1
57	29	115	42	1.097E+06	4.351E+06	0.252	34.8	0.04	68.4 ± 14.3
58	6	25	30	3.178E+05	1.324E+06	0.240	10.6	1.02	65.1 ± 29.7
67	11	35	42	4.162E+05	1.324E+06	0.314	10.6	1.26	85.1 ± 29.5
73	14	52	20	1.112E+06	4.132E+06	0.269	33.0	0.34	73.0 ± 22.1
75	22	58	70	4.994E+05	1.317E+06	0.379	10.5	1.16	102.6 ± 25.8
85	8	16	30	4.238E+05	8.475E+05	0.500	6.8	1.15	134.9 ± 58.5
86	23	103	100	3.655E+05	1.637E+06	0.223	13.1	1.06	60.6 ± 14.1
92	18	87	50	5.721E+05	2.765E+06	0.207	22.1	1.35	56.2 ± 14.6
	389	1742		3.965E+05	1.776E+06		14.2		

Area of basic unit = 6.293E-07 cm-2

Chi Squared = 57.768 with 30 degrees of freedom
P(chi squared) = 0.2 %
Age Dispersion = 30.674 %

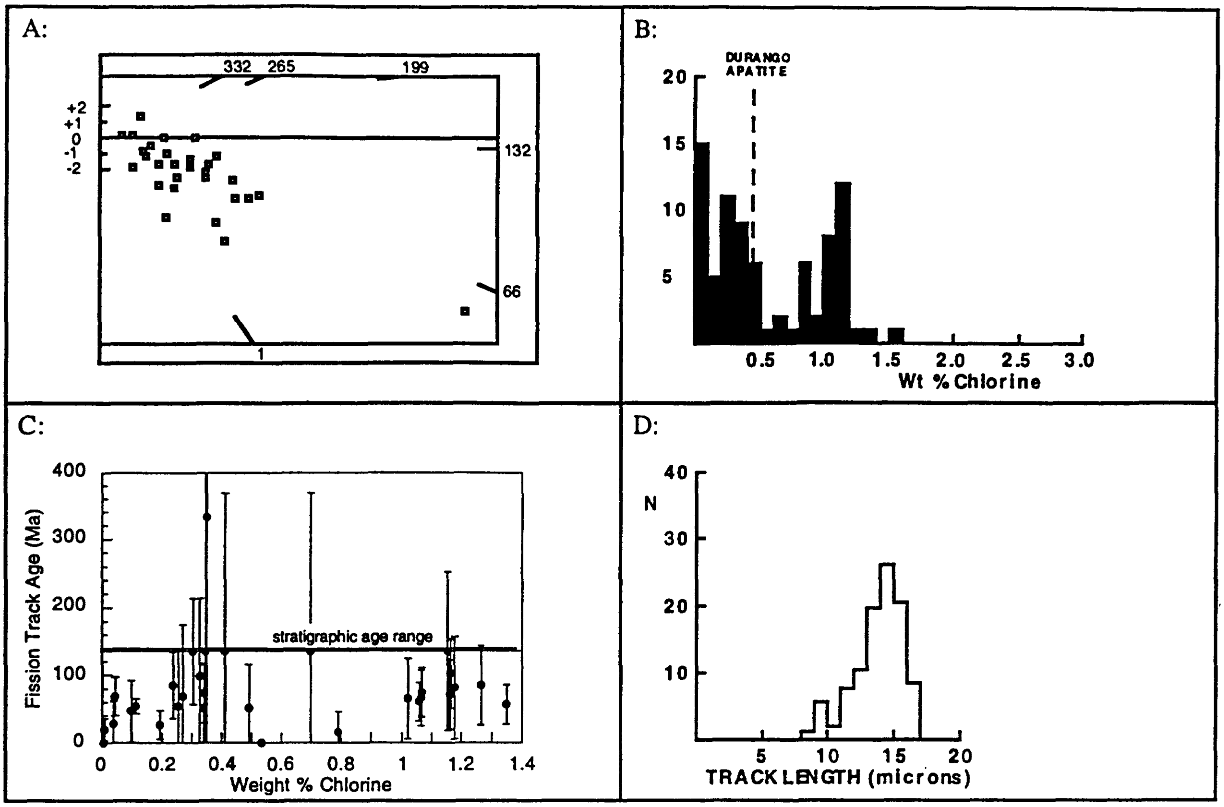
Ns/Ni = 0.223 ± 0.013
Mean Ratio = 0.288 ± 0.041

Ages calculated using a zeta of 382.4 ± 5.5 for CN5 glass
Rho D = 1.426E+06cm-2; ND = 2253
Rho D interpolated between top of can; Rho D = 1.397E+06cm-2, ND = 1099
bottom of can; Rho D = 1.467E+06cm-2, ND = 1154

POOLED AGE = 60.6 ± 3.7 Ma
CENTRAL AGE = 64.2 ± 6.1 Ma

USGS Sample 99TM-568A (continued)

GC763-41 APATITE CONTINUED 99TM-568A



GC763-42 APATITE

USGS Sample 99TM-576B

IRRADIATION G820
SLIDE NUMBER 7
COUNTED BY: SJM

Current grain no.	Ns	Ni	Na	RHOs	RHOi	RATIO	U (ppm)	Cl (wt%)	F.T. AGE (Ma)
9	20	58	40	7.945E+05	2.304E+06	0.345	18.3	0.03	93.7 ± 24.4
10	6	38	12	7.945E+05	5.032E+06	0.158	40.1	0.37	43.1 ± 19.0
11	1	11	36	4.414E+04	4.855E+05	0.091	3.9	0.06	24.8 ± 26.0
12	26	93	30	1.377E+06	4.926E+06	0.280	39.2	0.22	76.1 ± 17.0
13	0	5	30	0.000E+00	2.648E+05	0.000	2.1	0.00	0.0 ± 0.0
14	15	83	20	1.192E+06	6.595E+06	0.181	52.5	0.05	49.3 ± 13.9
15	1	10	60	2.648E+04	2.648E+05	0.100	2.1	0.00	27.3 ± 28.7
16	12	41	15	1.271E+06	4.343E+06	0.293	34.6	0.01	79.7 ± 26.2
19	6	27	32	2.980E+05	1.341E+06	0.222	10.7	0.03	60.6 ± 27.4
20	0	3	24	0.000E+00	1.986E+05	0.000	1.6	0.09	0.0 ± 0.0
21	4	9	28	2.270E+05	5.108E+05	0.444	4.1	0.02	120.6 ± 72.5
22	6	18	30	3.178E+05	9.534E+05	0.333	7.6	0.35	90.6 ± 42.8
26	10	56	20	7.945E+05	4.449E+06	0.179	35.4	0.01	48.7 ± 16.8
29	8	37	21	6.054E+05	2.800E+06	0.216	22.3	0.06	58.9 ± 23.0
30	0	7	24	0.000E+00	4.635E+05	0.000	3.7	0.00	0.0 ± 0.0
36	13	66	30	6.886E+05	3.496E+06	0.197	27.8	0.00	53.7 ± 16.4
37	20	77	28	1.135E+06	4.370E+06	0.260	34.8	0.17	70.7 ± 17.8
38	6	16	28	3.405E+05	9.080E+05	0.375	7.2	0.00	101.9 ± 48.8
43	3	10	18	2.648E+05	8.828E+05	0.300	7.0	0.23	81.6 ± 53.8
48	10	39	30	5.297E+05	2.066E+06	0.256	16.4	0.00	69.8 ± 24.8
53	39	180	25	2.479E+06	1.144E+07	0.217	91.1	0.18	59.1 ± 10.5
55	11	61	28	6.243E+05	3.462E+06	0.180	27.6	0.05	49.2 ± 16.2
68	27	73	15	2.860E+06	7.733E+06	0.370	61.6	0.51	100.5 ± 22.8
	244	1018		6.214E+05	2.592E+06		20.6		

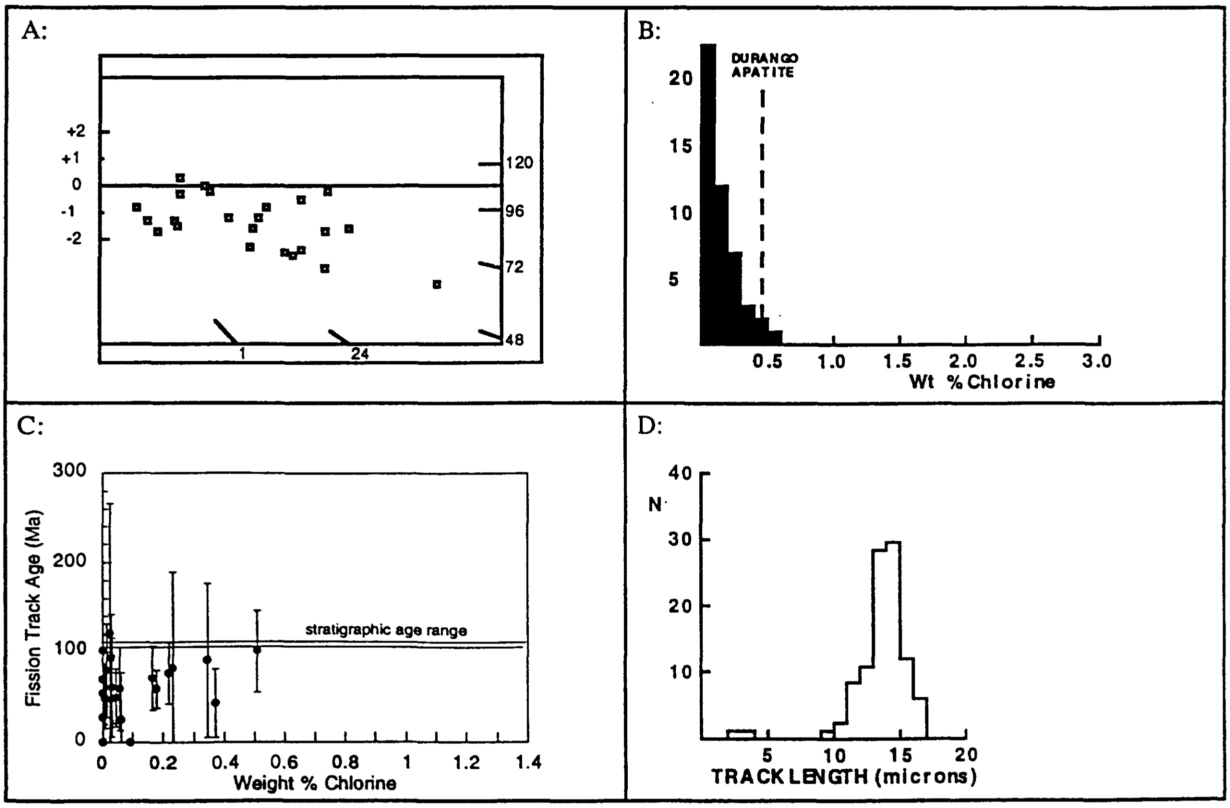
Area of basic unit = 6.293E-07 cm-2

Chi Squared = 18.886 with 22 degrees of freedom
P(chi squared) = 65.2 %
Age Dispersion = 2.250 % (did not converge)

Ns/Ni = 0.240 ± 0.017
Mean Ratio = 0.217 ± 0.025

Ages calculated using a zeta of 382.4 ± 5.5 for CN5 glass
Rho D = 1.432E+06cm-2; ND = 2253
Rho D interpolated between top of can; Rho D = 1.397E+06cm-2, ND = 1099
bottom of can; Rho D = 1.467E+06cm-2, ND = 1154

POOLED AGE = 65.3 ± 4.9 Ma
CENTRAL AGE = 65.3 ± 5.0 Ma



GC763-43 APATITE
IRRADIATION G820
SLIDE NUMBER 8
COUNTED BY: SJM

USGS Sample 99TM-578B

Current grain no.	Ns	Ni	Na	RHOs	RHOi	RATIO	U (ppm)	Cl (wt%)	F.T. AGE (Ma)
7	0	2	24	0.000E+00	1.324E+05	0.000	1.0	0.00	0.0 ± 0.0
8	0	1	49	0.000E+00	3.243E+04	0.000	0.3	0.00	0.0 ± 0.0
9	3	2	80	5.959E+04	3.973E+04	1.500	0.3	0.33	399.8 ± 365.1
11	76	151	60	2.013E+06	3.999E+06	0.503	31.7	0.61	136.9 ± 19.6
12	0	3	100	0.000E+00	4.767E+04	0.000	0.4	0.00	0.0 ± 0.0
13	1	7	80	1.986E+04	1.390E+05	0.143	1.1	0.33	39.2 ± 41.9
15	0	1	30	0.000E+00	5.297E+04	0.000	0.4	0.00	0.0 ± 0.0
17	0	2	70	0.000E+00	4.540E+04	0.000	0.4	0.00	0.0 ± 0.0
18	8	87	49	2.594E+05	2.821E+06	0.092	22.4	0.03	25.2 ± 9.3
19	5	8	80	9.932E+04	1.589E+05	0.625	1.3	2.80	169.6 ± 96.8
20	0	1	35	0.000E+00	4.540E+04	0.000	0.4	0.00	0.0 ± 0.0
21	0	2	36	0.000E+00	8.828E+04	0.000	0.7	0.00	0.0 ± 0.0
23	0	1	40	0.000E+00	3.973E+04	0.000	0.3	0.00	0.0 ± 0.0
24	0	1	56	0.000E+00	2.838E+04	0.000	0.2	0.00	0.0 ± 0.0
27	0	1	60	0.000E+00	2.648E+04	0.000	0.2	0.00	0.0 ± 0.0
34	96	190	36	4.238E+06	8.387E+06	0.505	66.5	0.08	137.4 ± 17.6
40	2	13	25	1.271E+05	8.263E+05	0.154	6.6	0.16	42.2 ± 32.0
41	5	13	48	1.655E+05	4.304E+05	0.385	3.4	0.42	104.9 ± 55.3
42	8	18	40	3.178E+05	7.151E+05	0.444	5.7	0.00	121.1 ± 51.5
43	33	51	48	1.092E+06	1.688E+06	0.647	13.4	0.66	175.5 ± 39.5
44	0	1	70	0.000E+00	2.270E+04	0.000	0.2	0.00	0.0 ± 0.0
46	1	6	36	4.414E+04	2.648E+05	0.167	2.1	0.41	45.7 ± 49.3
49	31	93	50	9.852E+05	2.956E+06	0.333	23.4	0.67	91.0 ± 19.0
50	30	148	80	5.959E+05	2.940E+06	0.203	23.3	0.69	55.5 ± 11.2
52	24	44	30	1.271E+06	2.331E+06	0.545	18.5	0.65	148.3 ± 37.8
53	8	41	20	6.356E+05	3.258E+06	0.195	25.8	0.64	53.4 ± 20.7
	331	888		3.949E+05	1.059E+06		8.4		

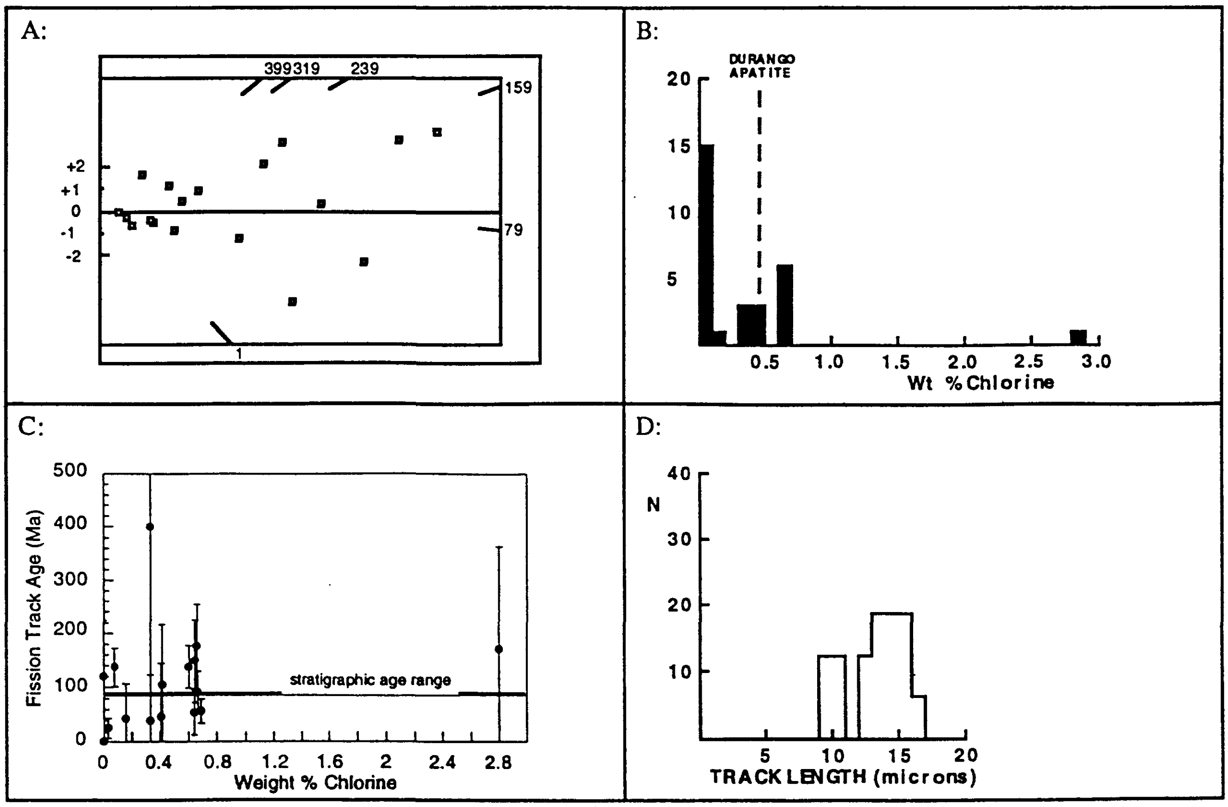
Area of basic unit = 6.293E-07 cm-2

Chi Squared = 61.272 with 25 degrees of freedom
P(chi squared) = 0.0 %
Age Dispersion = 46.002 %

Ns/Ni = 0.373 ± 0.024
Mean Ratio = 0.248 ± 0.067

Ages calculated using a zeta of 382.4 ± 5.5 for CN5 glass
Rho D = 1.438E+06cm-2; ND = 2253
Rho D interpolated between top of can; Rho D = 1.397E+06cm-2, ND = 1099
bottom of can; Rho D = 1.467E+06cm-2, ND = 1154

POOLED AGE = 101.7 ± 7.0 Ma
CENTRAL AGE = 89.8 ± 13.6 Ma



GC763-44 APATITE

IRRADIATION G820
SLIDE NUMBER 9
COUNTED BY: SJM

USGS Sample 99DH-52

Current grain no.	Ns	Ni	Na	RHOs	RHOi	RATIO	U (ppm)	Cl (wt%)	F.T. AGE (Ma)
11	5	36	35	2.270E+05	1.634E+06	0.139	12.9	0.09	38.2 ± 18.3
12	28	90	70	6.356E+05	2.043E+06	0.311	16.1	0.25	85.3 ± 18.6
13	2	13	48	6.621E+04	4.304E+05	0.154	3.4	0.06	42.3 ± 32.2
14	9	68	40	3.575E+05	2.701E+06	0.132	21.3	0.19	36.4 ± 13.0
15	1	37	36	4.414E+04	1.633E+06	0.027	12.9	0.00	7.5 ± 7.6
19	3	18	16	2.980E+05	1.788E+06	0.167	14.1	0.06	45.8 ± 28.6
21	7	35	35	3.178E+05	1.589E+06	0.200	12.5	0.77	55.0 ± 22.8
22	87	286	30	4.608E+06	1.515E+07	0.304	119.6	0.11	83.4 ± 10.4
23	2	9	16	1.986E+05	8.938E+05	0.222	7.1	0.75	61.1 ± 47.8
24	10	24	30	5.297E+05	1.271E+06	0.417	10.0	0.05	114.0 ± 43.0
25	6	28	35	2.724E+05	1.271E+06	0.214	10.0	0.00	58.9 ± 26.5
27	10	14	32	4.966E+05	6.952E+05	0.714	5.5	0.12	194.2 ± 80.6
28	1	6	60	2.648E+04	1.589E+05	0.167	1.3	0.05	45.8 ± 49.5
29	2	7	28	1.135E+05	3.973E+05	0.286	3.1	0.00	78.4 ± 62.9
30	6	24	35	2.724E+05	1.090E+06	0.250	8.6	0.00	68.6 ± 31.4
31	23	46	40	9.137E+05	1.827E+06	0.500	14.4	0.59	136.6 ± 35.1
35	3	11	15	3.178E+05	1.165E+06	0.273	9.2	0.01	74.9 ± 48.8
36	6	25	14	6.810E+05	2.838E+06	0.240	22.4	0.04	65.9 ± 30.0
39	14	74	42	5.297E+05	2.800E+06	0.189	22.1	0.10	52.0 ± 15.2
40	2	16	45	7.063E+04	5.650E+05	0.125	4.5	0.27	34.4 ± 25.8
41	7	15	38	2.927E+05	6.273E+05	0.467	5.0	0.62	127.6 ± 58.5
46	14	44	24	9.270E+05	2.913E+06	0.318	23.0	0.07	87.2 ± 26.9
76	31	60	36	1.368E+06	2.648E+06	0.517	20.9	1.35	141.1 ± 31.4
99	32	69	36	1.412E+06	3.046E+06	0.464	24.0	0.91	126.8 ± 27.3
110	97	402	76	2.028E+06	8.405E+06	0.241	66.4	0.01	66.3 ± 7.7
	408	1457		7.109E+05	2.539E+06		20.0		

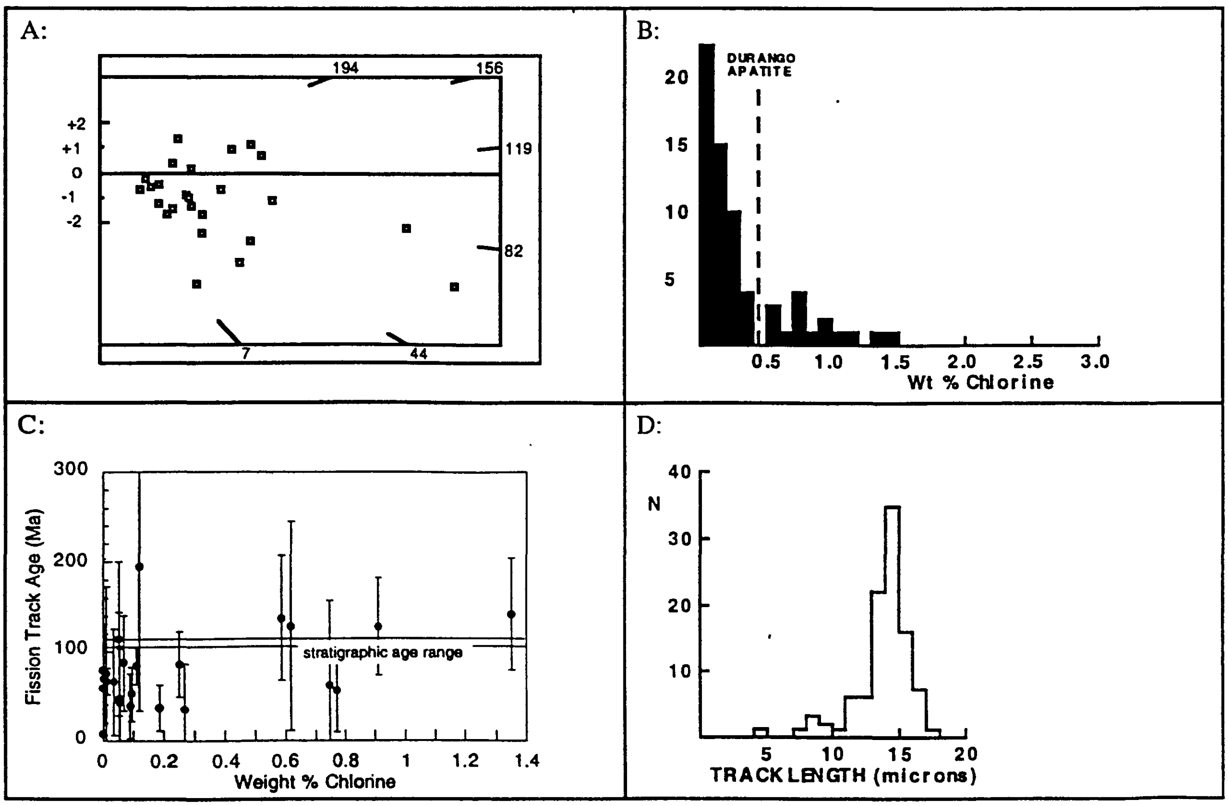
Area of basic unit = 6.293E-07 cm-2

Chi Squared = 50.487 with 24 degrees of freedom
P(chi squared) = 0.1 %
Age Dispersion = 35.543 %

Ns/Ni = 0.280 ± 0.016
Mean Ratio = 0.281 ± 0.031

Ages calculated using a zeta of 382.4 ± 5.5 for CN5 glass
Rho D = 1.444E+06cm-2; ND = 2253
Rho D interpolated between top of can; Rho D = 1.397E+06cm-2, ND = 1099
bottom of can; Rho D = 1.467E+06cm-2, ND = 1154

POOLED AGE = 76.8 ± 4.7 Ma
CENTRAL AGE = 75.9 ± 8.1 Ma



USGS Sample 99DH-54

GC763-45 APATITE 99DH-54

IRRADIATION G820
SLIDE NUMBER 10
COUNTED BY: SJM

Current grain no.	Ns	Ni	Na	RHOs	RHOi	RATIO	U (ppm)	Cl (wt%)	F.T. AGE (Ma)
3	8	17	80	1.589E+05	3.377E+05	0.471	2.7	0.51	129.1 ± 55.5
4	0	5	34	0.000E+00	2.337E+05	0.000	1.8	0.00	0.0 ± 0.0
5	0	4	35	0.000E+00	1.816E+05	0.000	1.4	0.00	0.0 ± 0.0
7	0	3	70	0.000E+00	6.810E+04	0.000	0.5	0.00	0.0 ± 0.0
8	0	19	42	0.000E+00	7.189E+05	0.000	5.7	0.43	0.0 ± 0.0
9	0	5	60	0.000E+00	1.324E+05	0.000	1.0	0.00	0.0 ± 0.0
10	6	7	32	2.980E+05	3.476E+05	0.857	2.7	0.45	233.3 ± 129.9
11	3	5	21	2.270E+05	3.783E+05	0.600	3.0	0.02	164.2 ± 120.0
12	0	3	50	0.000E+00	9.534E+04	0.000	0.7	0.00	0.0 ± 0.0
13	0	2	60	0.000E+00	5.297E+04	0.000	0.4	0.00	0.0 ± 0.0
14	0	2	56	0.000E+00	5.675E+04	0.000	0.4	0.00	0.0 ± 0.0
15	0	1	40	0.000E+00	3.973E+04	0.000	0.3	0.01	0.0 ± 0.0
16	0	3	60	0.000E+00	7.945E+04	0.000	0.6	0.00	0.0 ± 0.0
17	6	61	40	2.384E+05	2.423E+06	0.098	19.1	0.02	27.2 ± 11.7
18	0	8	40	0.000E+00	3.178E+05	0.000	2.5	0.00	0.0 ± 0.0
20	0	3	60	0.000E+00	7.945E+04	0.000	0.6	0.00	0.0 ± 0.0
21	0	4	35	0.000E+00	1.816E+05	0.000	1.4	0.01	0.0 ± 0.0
27	2	18	35	9.080E+04	8.172E+05	0.111	6.4	0.47	30.7 ± 22.9
28	0	3	60	0.000E+00	7.945E+04	0.000	0.6	0.00	0.0 ± 0.0
29	11	66	35	4.994E+05	2.997E+06	0.167	23.6	0.02	46.0 ± 15.0
	36	239		6.054E+04	4.019E+05		3.2		

Area of basic unit = 6.293E-07 cm-2

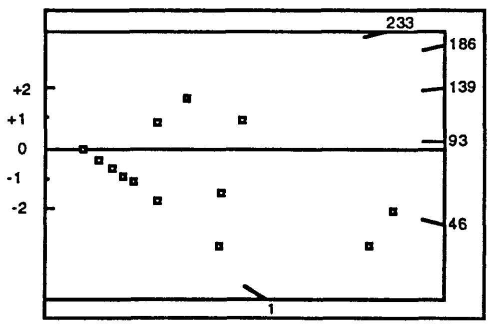
Chi Squared = 35.600 with 19 degrees of freedom
P(chi squared) = 1.2 %
Age Dispersion = 124.271 %

Ns/Ni = 0.151 ± 0.027
Mean Ratio = 0.115 ± 0.054

Ages calculated using a zeta of 382.4 ± 5.5 for CN5 glass
Rho D = 1.450E+06cm-2; ND = 2253
Rho D interpolated between top of can; Rho D = 1.397E+06cm-2, ND = 1099
bottom of can; Rho D = 1.467E+06cm-2, ND = 1154

POOLED AGE = 41.6 ± 7.5 Ma
CENTRAL AGE = 33.2 ± 12.9 Ma

A:



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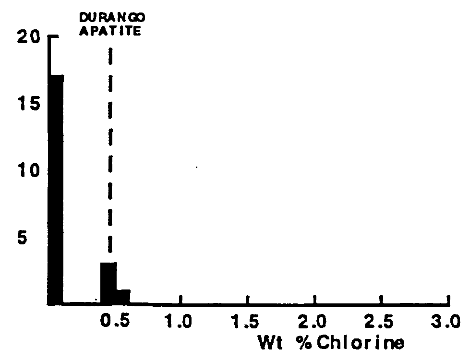

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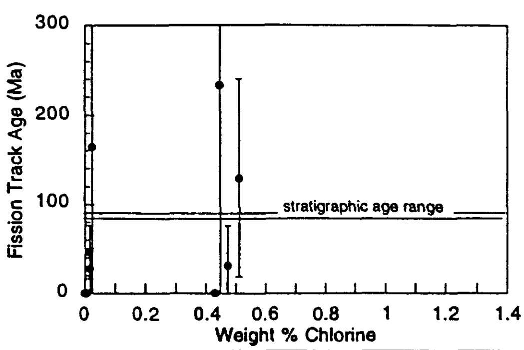


D: No confined tracks

GC763-46 APATITE

IRRADIATION G820
SLIDE NUMBER 11
COUNTED BY: SJM

USGS Sample 99DH-65B

Current grain no.	Ns	Ni	Na	RHOs	RHOi	RATIO	U (ppm)	Cl (wt%)	F.T. AGE (Ma)
4	26	35	38	1.087E+06	1.464E+06	0.743	11.5	0.11	203.5 ± 52.9
5	42	195	64	1.043E+06	4.842E+06	0.215	37.9	0.42	59.7 ± 10.3
6	3	2	40	1.192E+05	7.945E+04	1.500	0.6	0.76	404.5 ± 369.4
8	12	83	70	2.724E+05	1.884E+06	0.145	14.8	0.06	40.1 ± 12.4
10	3	4	25	1.907E+05	2.542E+05	0.750	2.0	1.05	205.4 ± 157.0
11	2	3	25	1.271E+05	1.907E+05	0.667	1.5	0.38	182.9 ± 167.0
12	1	3	25	6.356E+04	1.907E+05	0.333	1.5	0.31	92.1 ± 106.4
13	50	265	40	1.986E+06	1.053E+07	0.189	82.5	0.05	52.3 ± 8.2
14	19	88	50	6.038E+05	2.797E+06	0.216	21.9	0.63	59.8 ± 15.2
15	6	10	35	2.724E+05	4.540E+05	0.600	3.6	0.76	164.9 ± 85.2
16	20	46	32	9.932E+05	2.284E+06	0.435	17.9	0.50	119.9 ± 32.3
19	4	5	30	2.119E+05	2.648E+05	0.800	2.1	0.62	218.9 ± 146.9
20	11	84	30	5.827E+05	4.449E+06	0.131	34.9	0.14	36.3 ± 11.7
23	1	2	40	3.973E+04	7.945E+04	0.500	0.6	0.54	137.7 ± 168.6
24	5	11	30	2.648E+05	5.827E+05	0.455	4.6	1.11	125.3 ± 67.6
26	15	73	70	3.405E+05	1.657E+06	0.205	13.0	0.20	56.9 ± 16.2
27	6	6	64	1.490E+05	1.490E+05	1.000	1.2	2.19	272.5 ± 157.5
30	8	24	40	3.178E+05	9.534E+05	0.333	7.5	0.91	92.1 ± 37.7
31	3	7	35	1.362E+05	3.178E+05	0.429	2.5	0.35	118.2 ± 81.6
46	27	99	50	8.581E+05	3.146E+06	0.273	24.6	0.57	75.5 ± 16.5
61	39	128	21	2.951E+06	9.686E+06	0.305	75.9	0.02	84.2 ± 15.6
63	7	10	35	3.178E+05	4.540E+05	0.700	3.6	0.78	191.9 ± 94.7
72	24	108	24	1.589E+06	7.151E+06	0.222	56.0	0.16	61.5 ± 14.0
73	14	28	30	7.416E+05	1.483E+06	0.500	11.6	1.22	137.7 ± 45.2
74	61	198	48	2.019E+06	6.555E+06	0.308	51.3	0.40	85.2 ± 12.7
	409	1517		6.558E+05	2.432E+06		19.1		

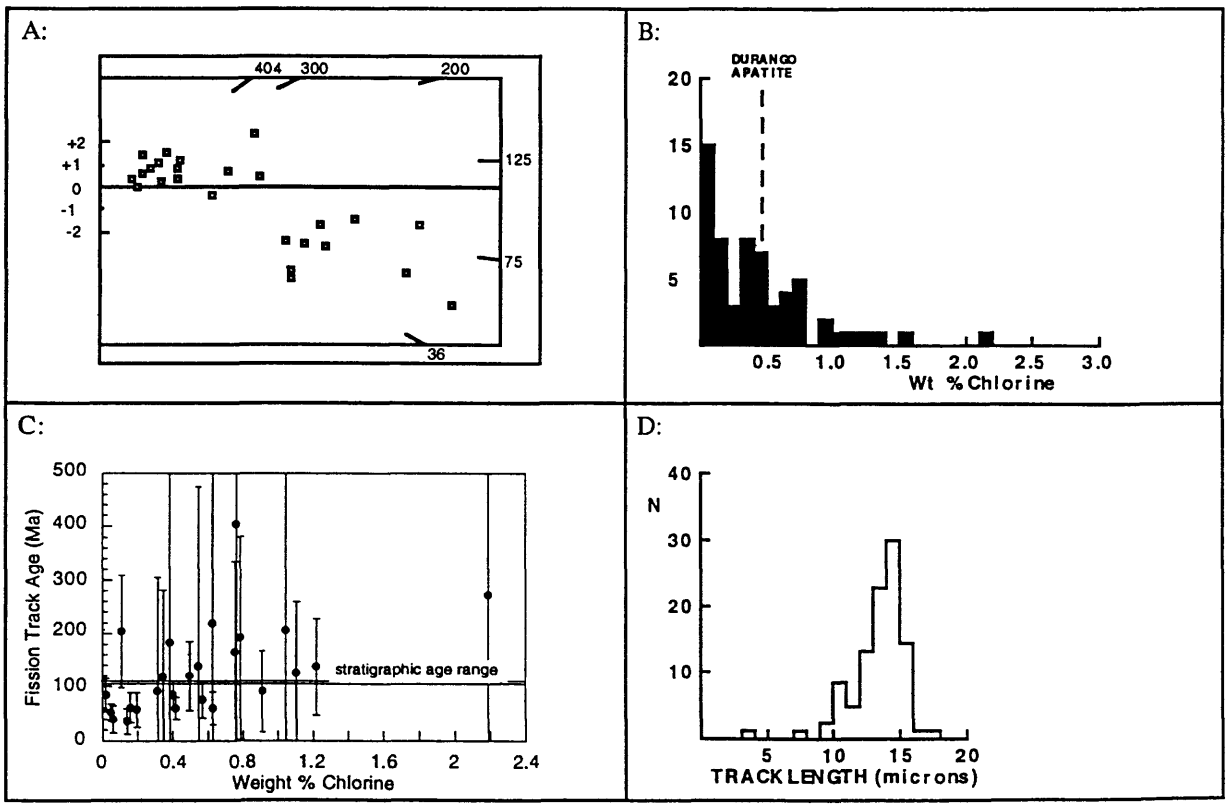
Area of basic unit = 6.293E-07 cm-2

Chi Squared = 68.877 with 24 degrees of freedom
P(chi squared) = 0.0 %
Age Dispersion = 39.843 %

Ns/Ni = 0.270 ± 0.015
Mean Ratio = 0.478 ± 0.063

Ages calculated using a zeta of 382.4 ± 5.5 for CN5 glass
Rho D = 1.455E+06cm-2; ND = 2253
Rho D interpolated between top of can; Rho D = 1.397E+06cm-2, ND = 1099
bottom of can; Rho D = 1.467E+06cm-2, ND = 1154

POOLED AGE = 74.6 ± 4.6 Ma
CENTRAL AGE = 91.2 ± 10.4 Ma



USGS Sample 99CP-A13

GC763-47 APATITE 99CP-A13

IRRADIATION G820
SLIDE NUMBER 12
COUNTED BY: SJM

Current grain no.	Ns	Ni	Na	RHOs	RHOi	RATIO	U (ppm)	Cl (wt%)	F.T. AGE (Ma)
3	36	107	72	7.945E+05	2.362E+06	0.336	18.4	0.20	93.3 ± 18.1
4	21	115	70	4.767E+05	2.611E+06	0.183	20.4	0.69	50.8 ± 12.1
7	10	78	56	2.838E+05	2.213E+06	0.128	17.3	0.40	35.7 ± 12.0
9	21	99	35	9.534E+05	4.495E+06	0.212	35.1	0.00	59.0 ± 14.3
10	0	1	42	0.000E+00	3.783E+04	0.000	0.3	0.00	0.0 ± 0.0
11	0	1	70	0.000E+00	2.270E+04	0.000	0.2	0.00	0.0 ± 0.0
14	0	7	35	0.000E+00	3.178E+05	0.000	2.5	0.98	0.0 ± 0.0
17	10	57	50	3.178E+05	1.812E+06	0.175	14.1	0.40	48.8 ± 16.8
18	7	24	30	3.708E+05	1.271E+06	0.292	9.9	0.70	81.0 ± 34.8
20	0	2	49	0.000E+00	6.486E+04	0.000	0.5	0.00	0.0 ± 0.0
21	11	82	60	2.913E+05	2.172E+06	0.134	16.9	0.83	37.4 ± 12.0
22	46	111	56	1.305E+06	3.150E+06	0.414	24.6	1.12	114.8 ± 20.3
23	0	11	32	0.000E+00	5.462E+05	0.000	4.3	0.38	0.0 ± 0.0
26	10	82	70	2.270E+05	1.861E+06	0.122	14.5	0.41	34.0 ± 11.4
27	4	18	40	1.589E+05	7.151E+05	0.222	5.6	0.76	61.8 ± 34.2
28	3	19	20	2.384E+05	1.510E+06	0.158	11.8	0.41	44.0 ± 27.3
29	3	19	100	4.767E+04	3.019E+05	0.158	2.4	0.30	44.0 ± 27.3
31	4	20	100	6.356E+04	3.178E+05	0.200	2.5	0.33	55.6 ± 30.5
32	7	43	48	2.317E+05	1.424E+06	0.163	11.1	0.41	45.3 ± 18.5
33	14	38	35	6.356E+05	1.725E+06	0.368	13.5	0.50	102.1 ± 32.0
34	30	161	100	4.767E+05	2.558E+06	0.186	20.0	0.67	51.9 ± 10.4
39	7	16	28	3.973E+05	9.080E+05	0.438	7.1	0.87	121.1 ± 55.0
62	12	57	70	2.724E+05	1.294E+06	0.211	10.1	0.28	58.6 ± 18.7
66	17	98	70	3.859E+05	2.225E+06	0.173	17.4	1.02	48.3 ± 12.7
44	4	22	28	2.270E+05	1.249E+06	0.182	9.7	0.83	50.6 ± 27.5
48	12	37	56	3.405E+05	1.050E+06	0.324	8.2	1.67	90.0 ± 30.0
51	12	56	50	3.814E+05	1.780E+06	0.214	13.9	0.43	59.6 ± 19.0
54	14	71	56	3.973E+05	2.015E+06	0.197	15.7	0.78	54.9 ± 16.1
71	13	39	24	8.607E+05	2.582E+06	0.333	20.1	1.10	92.5 ± 29.7
	328	1491		3.358E+05	1.527E+06		11.9		

Area of basic unit = 6.293E-07 cm-2

Chi Squared = 44.267 with 28 degrees of freedom
P(chi squared) = 2.6 %
Age Dispersion = 26.368 %

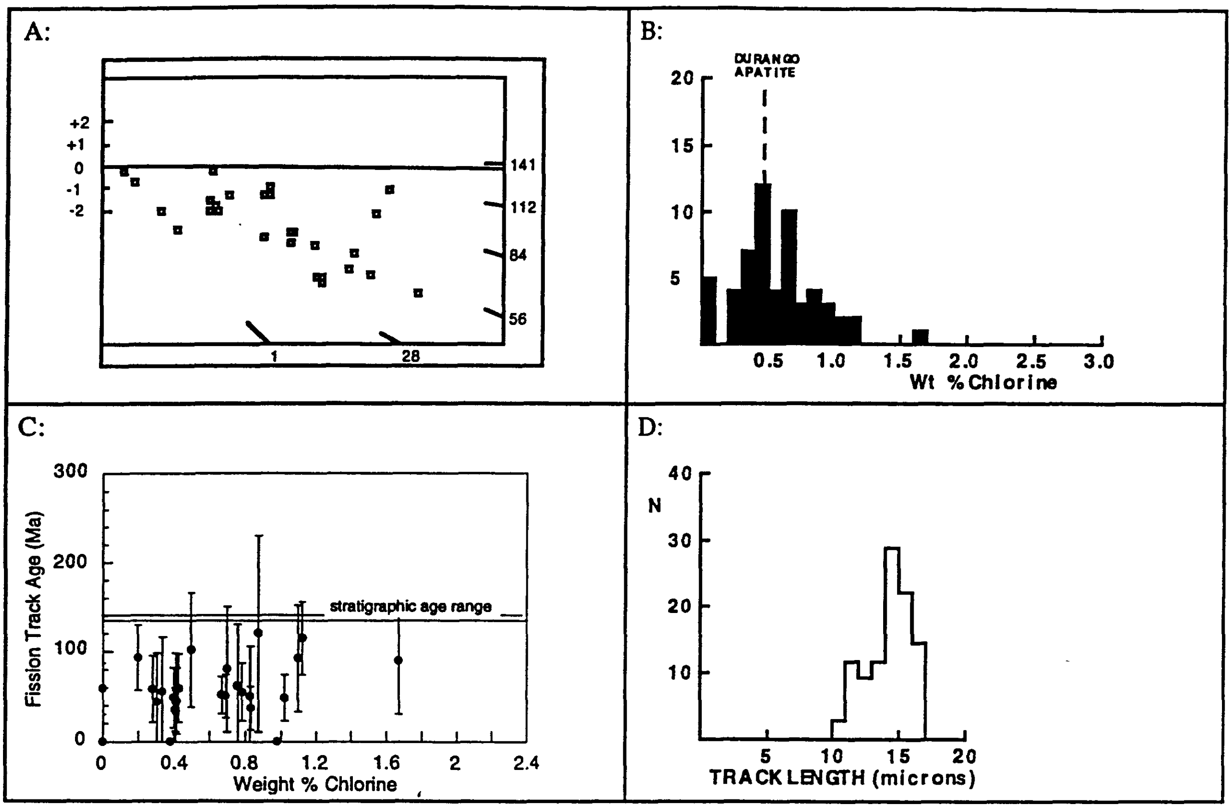
Ns/Ni = 0.220 ± 0.013
Mean Ratio = 0.191 ± 0.023

Ages calculated using a zeta of 382.4 ± 5.5 for CN5 glass
Rho D = 1.461E+06cm-2; ND = 2253
Rho D interpolated between top of can; Rho D = 1.397E+06cm-2, ND = 1099
bottom of can; Rho D = 1.467E+06cm-2, ND = 1154

POOLED AGE = 61.2 ± 4.0 Ma
CENTRAL AGE = 60.2 ± 5.3 Ma

USGS Sample 99CP-A13 (continued)

GC763-47 APATITE CONTINUED 99CP-A13



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