Public-data File 91-13

TIMING OF TECTONIC EVENTS ON THE NORTH SLOPE OF ALASKA: BY APATITE FISSION TRACK ANALYSIS, AND A COMPARISON BETWEEN THESE TECTONIC EVENTS AND THE OFFSHORE SEDIMENTARY RECORD

by

Paul B. O'Sullivan

Department of Geology
LaTrobe University
Bundoora, Victoria 3083
Australia

and

Alaska Division of
Geological and Geophysical Surveys

April 1991

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

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

CONTENTS

INTRODUCTION

The Arctic Coastal Plain of northern Alaska has recently been receiving a great deal of attention, primarily because the deep sedimentary basin (Colville Trough) beneath the coastal plain is believed by many to contain major hydrocarbon accumulations (e.g. Mast et al., 1980) analogous to the Prudhoe Bay Field. Along the northern flank of the Colville Trough in the Prudhoe Bay region and to the west in the National Petroleum Reserve-Alaska (NPRA), the geologic relationships are relatively uncomplicated and have not experienced post-depositional deformation (Mull, 1982).

However, to the east the geologic relationships along the northern flank of the Colville Trough in the Arctic National Wildlife Refuge (ANWR) are complicated by compressional deformation, caused by the advancing Brooks Range fold and thrust belt, which extends northward across the coastal plain of ANWR. This deformation in the northeastern Brooks Range (NEBR) extends further north but involves less displacement and shortening than seen in the remainder of the Brooks Range (Wallace and Hanks, 1988a, b, 1990). O'Sullivan (1988) and O'Sullivan et al. (in prep) report uplift and erosion events at ~60 Ma, ~45 and ~20 Ma, resulting in development of east-trending anticlinoria within this advancing fold and thrust belt.

The opening of the Canada Basin during the Late Jurassic resulted in the initiation of the Late Jurassic to Tertiary Brookian orogeny (Mull, 1982). During uplift of the Brooks Range to the south, material was shed from the northward-verging deformed rocks to be deposited in the Colville Trough (Mull, 1985). Unfortunately, due to removal of large sections of the stratigraphic record, many details of the burial and thermal history of the post Jurassic sedimentary basin are poorly understood and timing of post Cretaceous structural events are poorly constrained (Bird, 1987).

Recently, authors have reported that fission tracks from detrital apatites within sedimentary sequences preserve a record of the thermal history of the host rock when cooled below temperatures of approximately 120°C (e.g. Gleadow et al. 1983; Gleadow et al. 1986a; Gleadow and Duddy, 1984; Green et al. 1989a,b). No other geochronological technique is sensitive to temperatures of this order. It has been shown that for times on the order of millions of years, fission track ages and the length of confined tracks are reduced by temperatures between ~60 and 120°C (Gleadow et al. 1983; Green et al. 1986). In fact, the reduction of confined track lengths leads to the reduction of apparent fission track age; and the distribution of the confined track lengths in an apatite directly reflects the thermal history of a sample (Gleadow et al. 1986a; Green et al. 1989a,b). By combining both age data and confined length measurements, Apatite Fission Track Analysis (AFTA) provides not only estimates of maximum temperatures and the time of cooling from maximum temperatures (e.g. Gleadow et al. 1983; Green et al. 1989a), but also allows determination of the thermal history (time-temperature path) experienced by the host rock (Green et al. 1989b).

Fission tracks in apatites from a thick sequence of rocks may record uplift over a period of time through the effective apatite closure temperature. By estimating paleogeothermal gradients, the rate of uplift and denudation can be constrained for the sequence (e.g. Dodge and Naeser, 1968; Wagner et al. 1977). Examples where fission track data have been previously applied to constrain the cooling histories and uplift rates in mountain belts include: the Himalayas (Zeitler et al. 1982; Zeitler, 1985), the Alps (Wagner and Reimer, 1972; Wagner et al. 1977), the western United States (Naeser, 1979; Naeser et al. 1983), the northern Appalachians (Miller and Lakatos, 1983; Miller and Duddy, 1989), western British Columbia (Harrison et al. 1979, Parrish, 1983), Antarctica (Gleadow and Fitzgerald, 1984; Gleadow and Fitzgerald, 1987), and the northeastern Brooks Range (O'Sullivan 1988; O'Sullivan et al. 1989, 1990a, b, and in prep).

This report presents the final results of a two-year AFTA study of Mississippian through Tertiary sedimentary rocks from 2 outcrop regions and five wells on the North Slope of Alaska. AFTA results from the Umiat-Colville River region, and the Sagavanirktok River region will be discussed. Originally, the Franklin Bluffs region just south of Prudhoe Bay was to be discussed as well, unfortunately samples collected from Franklin Bluffs did not yield apatite. The five wells from which AFTA data was generated include Husky Tunalik Test Well #1, Husky Walakpa Test Wells #1 and #2, Husky Inigok Test Well #1, and Exxon Alaska State C-1.

Final interpretations of fission track ages and confined track length measurements indicate varied histories for the different regions. AFTA data on outcrops in the Umiat-Colville River region (O'Sullivan, 1989a, and unpublished results) indicate the Early Cretaceous (Albian) sedimentary rocks in the foothills south of Umiat experienced deep burial and temperatures greater than 120°C followed by a rapid uplift/erosion event in the early Tertiary (Paleocene, ~57 Ma). Data on Late Cretaceous and Tertiary sediments exposed north of Umiat along the Colville River, show those sediments have not experienced temperatures greater than ~50°C subsequent to deposition. AFTA data on the Sagavanirktok River region (O'Sullivan, 1989b) indicate that samples collected along two vertical traverses through Marmot Syncline near Slope Mountain, record an uplift/erosion event during the early Tertiary (Eocene, ~52 Ma). Further north along the Sagavanirktok River, AFTA data on early Tertiary sediments exposed along Sagwon Bluffs indicate the sediments have not experienced temperatures greater than ~40°C subsequent to deposition.

Modelling of AFTA data from the 5 wells (O'Sullivan, 1989c, 1990), located in NPRA and east of Prudhoe Bay along the coast, also indicates varied histories for the different regions. Data from the Inigok #1 well indicate two distinct uplift/erosion events resulting in the net removal of ~1-2 km of section. The first event occurred during the Paleocene at ~55-60 Ma and the second during the Miocene at ~20-25 Ma. Data from the Tunalik #1 well also indicate two distinct uplift/erosion events resulting in the net removal of ~3-3.5 km of section. The first occurred during the Late Cretaceous (Campanian) at ~80-85 Ma and the second during the Miocene at ~20-25 Ma. Data from the two Walakpa wells indicate that samples collected from the base of the well have not experienced temperatures greater than ~90°C subsequent to deposition. Modelling of the data indicates the section has also experienced two uplift/erosion events resulting in the net removal of ~1-2 km. The first of these occurred during the Late Cretaceous/Early Tertiary (?) and the second during the Miocene at ~20-25 Ma. Data from the Exxon Alaska State C-1 are inconclusive except to indicate that the section is presently experiencing its maximum paleotemperature.

Also presented in this report are the results of a comparison between the timing of tectonic uplift events due to thrusting in northeastern Alaska, determined using AFTA (O'Sullivan, 1988;

O'Sullivan et al. 1989, 1990a,b), and the seismic record onshore and offshore in the southern Beaufort Sea. The comparison of the age of regional unconformities mapped in the subsurface to the regional uplift events shows that tectonic events were more important than eustatic changes in controlling the occurrence of regional unconformities mapped offshore (McMillen and O'Sullivan, in press).

PURPOSE AND SCOPE

This report presents the results from 61 samples from two outcrop locations: the Umiat-Colville River region (n=20); along the Sagavanirktok River (n=13); and five drill holes (n=28): Husky Tunalik Test Well #1, Husky Walakpa Test Wells #1 and #2, Husky Inigok Test Well #1, and Exxon Alaska State C-1 (Fig. 1). Due to the absence of apatite in samples from Franklin Bluffs, it is not possible to present data from that locality.

The results given here are the interpreted results from a two year study, the purpose of which was to constrain the Mesozoic and Cenozoic uplift/erosion and thermal history of sedimentary rocks on the North Slope of Alaska using AFTA and then to try to relate this uplift history onshore to the sedimentary record offshore. Sedimentary rocks from wells and exposures on the North Slope provide a record of the timing of onshore structural events, as well as a means of deciphering the thermal history of the rocks since Late Jurassic to Tertiary orogenic events responsible for the development of the Brooks Range to the south. Seismic reflection and well log data of Tertiary strata from the offshore region of northeastern Alaska provide a record of Cenozoic deposition in response to development of the Brooks Range, whereas onshore these strata have been eroded.

The AFTA method involves determination of an apparent fission track age and a distribution of confined track lengths (an indication of the sample's thermal history). The methodology for this technique is described briefly in the section titled "Experimental Details". A detailed treatment of the AFTA technique is presented in O'Sullivan (1988). By measuring and comparing apparent fission track ages and distributions of confined lengths in detrital apatites from sedimentary rocks, it is possible to construct an implied thermal history for the samples. In order to project the Mesozoic and Cenozoic uplift and thermal history of sedimentary rocks on the North Slope into the offshore continental shelf, McMillen and O'Sullivan (in press) compared available seismic and well log data from the coastal plain and the southern Beaufort Sea with timing of uplift/erosion events determined using AFTA.

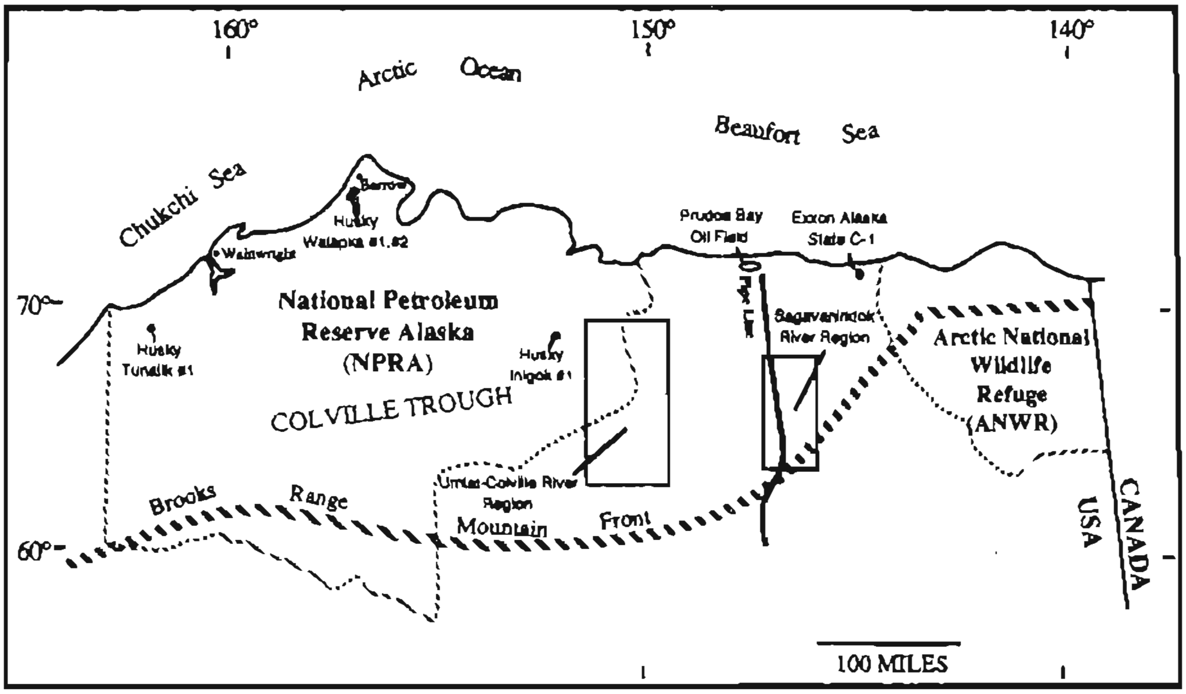


Figure 1: Map showing approximate locations of regions and wells from which fission track analyses have been completed for this study. These include two outcrop sampling areas: the Umiat-Colville River Region, including sample locations in the foothills south of Umiat and along the Colville River; and the Sagavanirktok River Region, including sample locations along the Sagavanirktok River and near Slope Mountain. Four wells drilled in NPRA from which data has been interpreted include Husky Tunalik #1, Husky Walakpa #1, and #2, and Husky Inigok #1. AFTA data from Exxon Alaska State C-1 located east of Prudhoe Bay has also been interpreted.

Selection of the outcrop localities was based on several factors including available exposures and logistics. Continuous exposures of Cretaceous and Tertiary units are limited and the best exposures are found along major river banks. Field work for this study was conducted from June to August, 1988 and from June to July, 1989, as part of the summer field program by the State of Alaska Division of Geological and Geophysical Surveys (ADGGS). Selection of wells was based on availability of sample material and proximity to the northern coastline of Alaska. Well material was collected during December, 1988 and May 1989, from the Alaska State Core Depository in Eagle River, Alaska.

ACKNOWLEDGEMENTS

Financial support for Paul O'Sullivan, while he was completing this study, was received through a grant from the U.S. Minerals Management Service Continental Margins Project and a LaTrobe University Post-Graduate Scholarship. Field and logistical support for Paul O'Sullivan was provided by Mark Robinson, Gar Pessel, and John Decker of the State of Alaska Division of Geological and Geophysical Surveys. Cooperation from the Alaska State Core Depository and help with sampling was recieved from John Reeder (ADGGS). Six samples from the Umiat-Colville River region (89 KIL 1C-6C) were supplied by John Decker and Steve Bergman of ARCO. Shipment of samples from Alaska to Melbourne Australia was provided by Steve Bergman of ARCO. Support for sample irradiations was supplied through the Australian Atomic Energy Commission's HIFAR Reactor. Sample preparation and fission track mounts for samples from the Sagwon Bluffs and the Kongakut section were prepared by Glen Duddy of Geotrack International. Editing and comments by John Murphy and Andrea O'Sullivan of LaTrobe University helped to make this report infinitely better.

REGIONAL GEOLOGY

The North Slope of Alaska represents a combined passive continental margin and foreland basin bounded to the north by the Arctic Ocean and to the south by the Brooks Range, a Late Jurassic to Tertiary fold and thrust belt (Mull, 1982). The stratigraphy of the Brooks Range and the North Slope can be divided into three major unconformity-bounded stratigraphic sequences (Lerand, 1973; Mull, 1982; Bird and Molenaar, 1987). The Proterozoic to Middle Devonian Franklinian sequence, consisting of marine and nonmarine miogeosynclinal and eugeosynclinal sedimentary rocks (Grantz and May, 1983), documents a complex and poorly understood history culminating in a late Devonian orogenic event. The Mississippian to Lower Cretaceous Ellesmerian sequence (Fig. 2) was deposited on a south-facing (present coordinates) passive margin with both platformal and basinal stratigraphic components. The Lower Cretaceous and younger Brookian sequence consists of clastic deposits derived from erosion of the Brooks Range orogen to the south. The stratigraphy of these sequences has been discussed in detail by many authors (e.g. Brosge and Tailleur, 1970; Detterman et al. 1975; Palmer et al. 1979; Grantz and May, 1983; Hubbard et al. 1987).

Northern Alaska has experienced a complicated structural history. Prior to the Late Devonian, the tectonic setting is highly speculative because of the fragmentary stratigraphic evidence (Bird, 1987; Hubbard et al. 1987). During Late Devonian and Early Mississippian time, the Ellesmerian orogeny deformed the Franklinian rocks. Two belts of two-mica granitic intrusives, one along the core of the central Brooks Range and the other in the Romanazof Mountains, have Late Devonian (390-360 Ma) U-Pb zircon ages and are a result of this Devonian event (Sable, 1977; Dillon et al. 1987). Subsequent erosion of the uplifted rocks created a major unconformity on which the Mississippian to Lower Cretaceous platform limestones and terrigenous clastic rocks of the Ellesmerian sequence were later deposited (Hubbard et al. 1987; Bird, 1987).

Rifting to the north during the Jurassic and Early Cretaceous formed the proto-Canada Basin and caused renewed basement uplift along the east-west trending Barrow Arch (Hubbard et al. 1987). The Barrow Arch is a long-lived buried basement high located approximately along the present

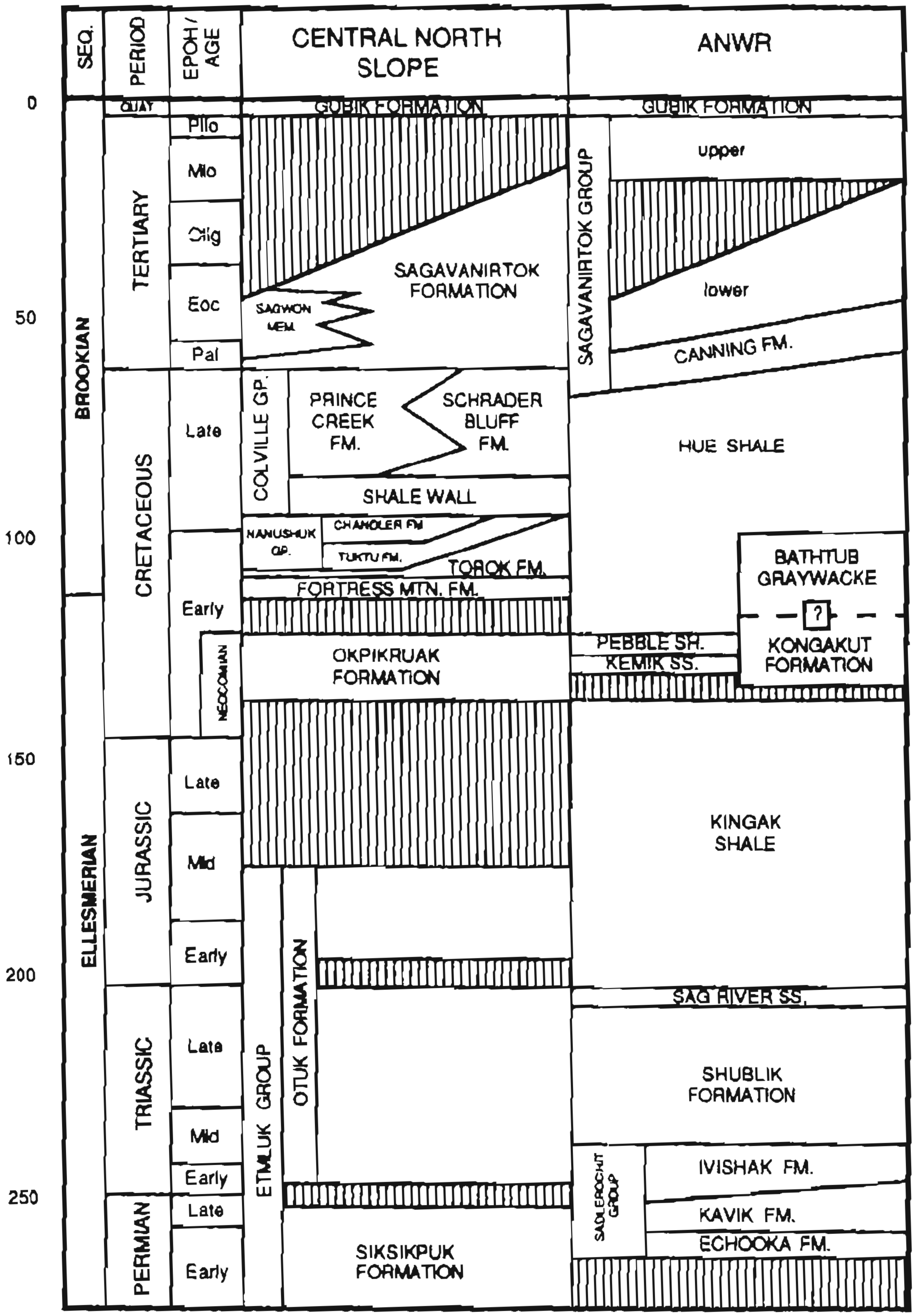


Figure 2: Generalized Permian-present stratigraphy of northern Alaska.

northern shoreline of Alaska. During Neocomian time, uplift of the rifted margin to the north resulted in a regional unconformity. To the south, continental subduction and mountain building created the ancestral Brooks Range (Bird, 1987). The relationship between the rifting and the Brooks Range orogeny is unknown. This orogeny shifted the sediment source from north to south and later formed many of the structural features preserved in the area. The influx of synorogenic clastic sediment prograding northeastward into the Colville trough (the foredeep of the Brooks Range: Mull, 1985) is the first sedimentologic evidence of the Brooks Range orogen (Grantz and May, 1983).

Major tectonic elements of the Brooks Range are dominated by the Brooks Range fold-thrust belt which formed in the mid-to-Late Cretaceous (Leiggi, 1987). Rocks of the Brooks Range may be divided into several belts which trend sub-parallel to the strike of the range. The core of the range is characterized by highly deformed allochthonous rocks representing estimated crustal shortening of up to 400 km (Rattey, 1987). In comparison, parautochthonous rocks in the NEBR are relatively undeformed and represent significantly less shortening and displacement than in the core of the range (Mull, 1982; Oldow et al. 1987).

The coastal plain can be divided into two structural zones (Bruns et al. 1987), the undeformed zone and the deformed zone, marked by increasingly complex deformation from west to east. Rocks in the undeformed zone in the northwest part of the coastal plain are characterized by almost flat-lying strata cut by normal faults with only small displacement. The deformed zone is located north of the NEBR. The boundary between the two zones lies on the northern flank of the Marsh Creek structural trend. This trend is mapped as the Marsh Creek Anticline on surface geological maps (Bader and Bird, 1986), but consists of a set of subparallel thrust-faulted anticlines that trend northeastward (Bruns et al. 1987). The rest of the deformed zone is similarly characterized by thrust-faulted basement highs overlain by northeast-trending complexly deformed structures.

EXPERIMENTAL DETAILS

Apatites were separated from all 61 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 Commission's 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. Approximately 20 grains were counted from each sample, depending on the number of suitable grains available, the available counting area per grain, and the spontaneous and induced track densities. 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 in the Department of Geology at La Trobe University, 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). A personal zeta calibration factor of 352.7 was determined empirically using apatite age standards with independently known ages. Age standards used in this study include Fish Canyon Tuff, Durango (Mexico), and the Mt. Dromedary monzonite (Green, 1985). 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 (χ^2) statistic (Galbraith, 1981), the mean age provides a useful measure (Green, 1981). The χ^2 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. 1989b).

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 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. 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.

Gleadow et al. (1986b) and Green et al. (1989a,b) have explained the principles of interpretation of confined fission track length distributions in apatite. When they form, fission tracks in apatite have a fairly constant mean length of ~16 μm (Gleadow et al. 1983; Gleadow et al. 1986b). Following their formation, fission tracks in apatite shorten progressively (anneal) at a rate which depends primarily on temperature (Fleischer et al. 1975; Gleadow et al. 1986b and Green et al. 1989b). Therefore, increased annealing results in shorter tracks, reduced track density, and a reduction in the fission track age (Gleadow et al. 1986b and Green et al. 1989a,b). Total annealing results in the reduction of the fission track age to zero. Since new tracks form continuously throughout geological time, the distribution of track lengths in a detrital apatite grain therefore reflects the integrated thermal history of its host rock (Green et al. 1989b).

In rapidly cooled rocks (such as volcanics or rapidly uplifted basement terranes) which have not been heated above ~50°C subsequent to their original cooling, the fission track length distributions are characteristically narrow (standard deviation = ~1 μm) with most tracks between 13 and 16 μm, and a mean between ~14-15 μm. Only for those apatites with such a length distribution does the fission track age represent a distinct event in terms of rapid cooling (Gleadow et al., 1986b; Green, 1986). Any other type of length distribution reflects the thermal history experienced by the sample (Green et al. 1989a,b).

In this study, AFTA data have been interpreted using the understanding of AFTA system response described by Green et al. (1989b). This understanding is based on an empirical kinetic description of laboratory annealing data in Durango apatite (Green et al. 1986; Laslett et al. 1987), employing the principle of "equivalent time" described by Duddy et al. (1988).

In detail, the rate of annealing depends on the chemical composition, with tracks in apatites richer in chlorine being slightly more resistant to annealing than tracks in fluor-apatites (Green et al. 1985, 1986; Sieber, 1986). The Durango apatite, on which the interpretation of the data in this paper is based, has a Cl/F ratio close to the model value found in a compilation of apatite compositions both from the literature and by experimental measurements (Sieber, 1986) and should therefore provide a good basis for interpretation. Likely variation in apatite compositions could lead to errors in estimated paleotemperatures of ~±10°C, which is of the same order as the uncertainty associated with the extrapolation of the laboratory based annealing description to geological timescales.

STUDY LOCATIONS

Two major south-to-north traverses across the North slope of Alaska were selected for the purpose of separating out detrital apatites from sedimentary rocks from known stratigraphic intervals. Sampling took place from: 1) the foothills region south of Umiat and then north along the Colville River, and 2) the Slope Mountain region and then north along the Sagavanirktok River (Fig. 1). Five drill holes; Husky Tunalik Test Well #1, Husky Walakpa Test Wells #1 and #2, Husky Inigok Test Well #1, and Exxon Alaska State C-1 were also sampled at known intervals for AFTA work (Fig. 1).

Umiat-Colville River Region

The Umiat-Colville River region located along the eastern boundary of NPRA (Fig. 1), consists of deformed Early Cretaceous marine deposits and undeformed Late Cretaceous to Tertiary marine and non-marine deposits. In the foothills region south of Umiat, the sampled sedimentary rocks (Fig. 3) include marine shales and sands of the Torok Formation and marine sands from the Tuktu Formation (Albian) of the Nanushuk Group (Albian to Cenomanian). Samples taken along the Colville River include marine and non-marine sands and shales of the Colville Group (Cenomanian to Maestrichtian) and non-marine sands of the Sagavanirktok Formation (Paleocene to Eocene).

Subsequent to deposition, the Albian-to-Cenomanian age rocks outcropping to the south of Umiat have been uplifted and deformed into broad anticlines and synclines. The younger sediments exposed further to the north along the Colville River have not been deformed since deposition and are relatively flat lying.

Sagavanirktok River Region

The Sagavanirktok River region, located approximately 100 km east of the Colville River (Fig. 1), consists of poorly exposed, mildly deformed and undeformed Cretaceous and Tertiary marine to non-marine sedimentary rocks. Sampling from this region included two vertical sections near Marmot Syncline (Fig. 4) and a horizontal section further north along the Sagavanirktok River along the Sagwon Bluffs (Fig. 5). The first of the two vertical sections, located at Slope Mountain (hereafter referred to as the "Slope Mountain section"), includes gently dipping prodelta shale of the

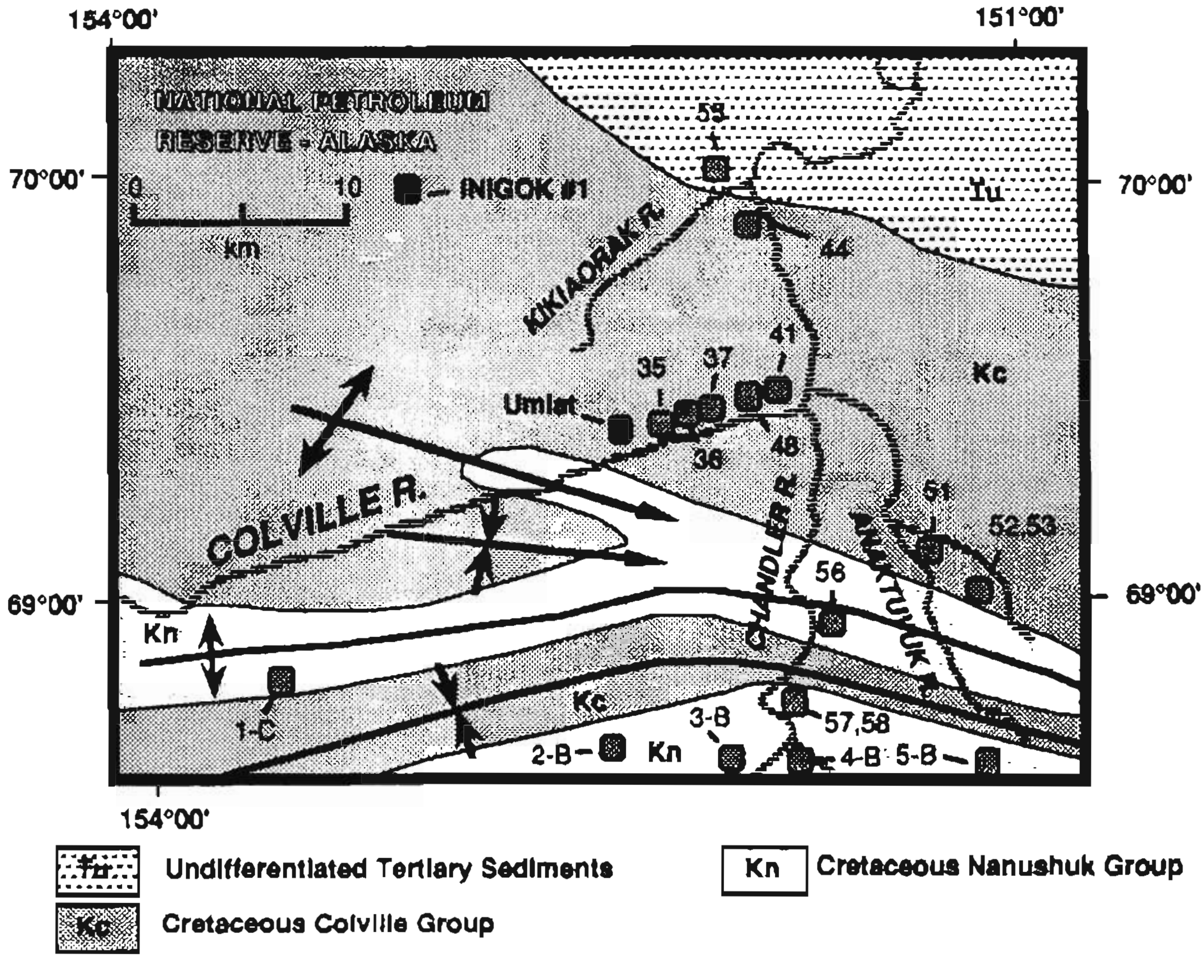


Figure 3: Map showing approximate locations of samples (88 POS __, and 89 KIL ___) collected from the Umiat-Colville River region.

Torok Formation exposed at the base, conformably overlain by marine sands of the Tuktu Formation and marine-to-non-marine sands of the Chandler Formation (Albian to Cenomanian) of the Nanushuk Group. Subsequent to deposition, the sedimentd exposed at Slope Mountain have been uplifted and deformed into the Marmot Syncline. Five samples from the Tuktu and the Chandler Formations were collected for AFTA analysis along a traverse down the south flank of the syncline where the beds are dipping ~20° to the north (Fig. 6).

The second vertical section (hereafter referred to as the "Kongakut section"), is located 10 km due east of the Slope Mountain section (Fig. 4). The Kongakut section, as mapped by Brosge et al. (1979), includes internally deformed marine shales and siltstones of the Kongakut Formation

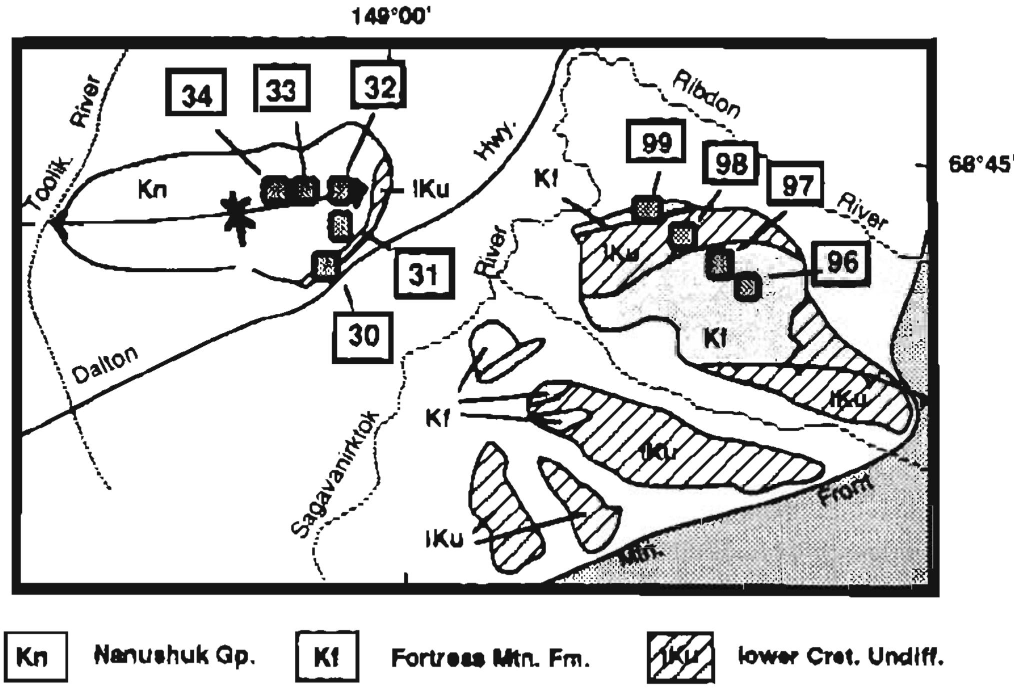


Figure 4: Map showing approximate locations of samples (88 POS __. and 89 POS __) collected from: the Slope Mountain section (88 POS 30-34); and Kongakut section (89 POS 96-99) within the Sagavanirktok River region.

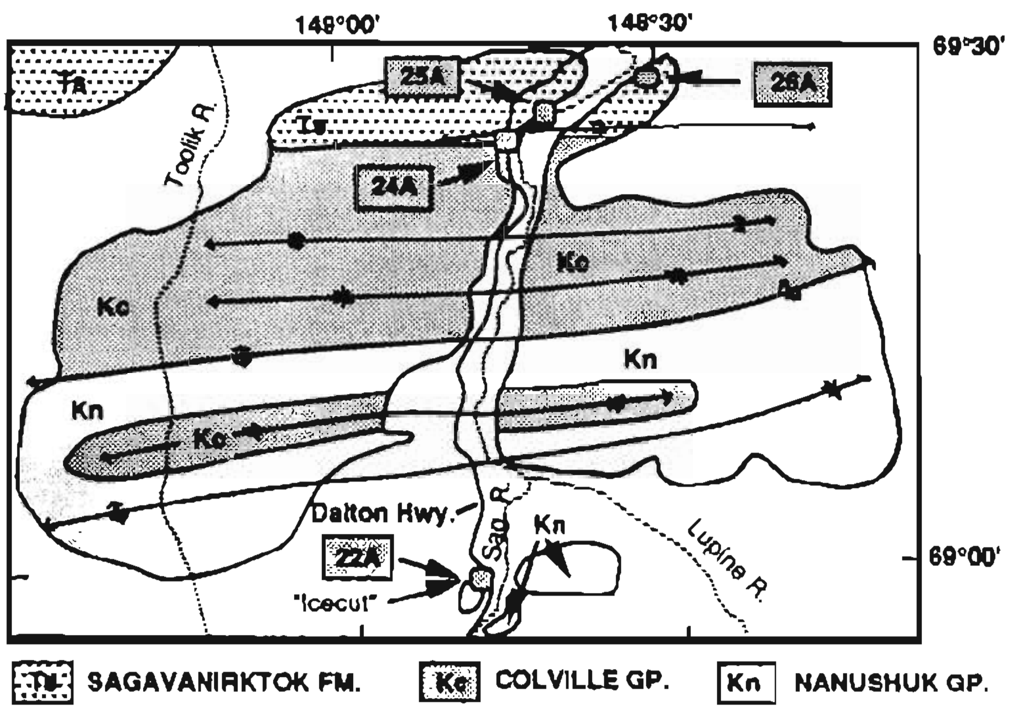


Figure 5: Map showing approximate locations of samples (88 POS __) collected from: the Icecut (88 POS 22A); and from the Sagwon Bluffs section (88 POS 24-26A).

(Neocomian) sandwiched between two competent slabs of fine-grained marine sands of the Fortress Mountain Formation (Albian) (Fig. 7). The upper slab of Fortress Mountain strikes at ~N 70° E and dips ~50° to the north whereas the lower slab strikes at ~N 75° E and dips 80° to the south. The contact between the upper slab and the Kongakut Formation is gradational. The Kongakut section, which stratigraphically underlies the Slope Mountain section, has been uplifted and repeated along a proposed fault (Fault 1 in Fig. 7) in the shale unit mapped as Kongakut Formation.

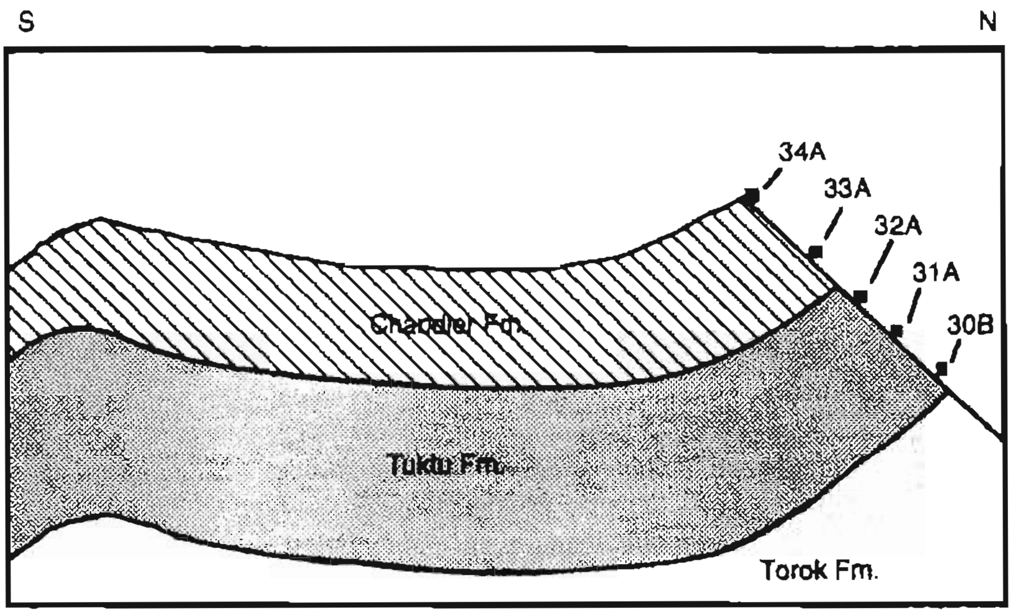


Figure 6: Cross-section of the Slope Mountain section showing relative positions of the five AFTA samples (88 POS 30-34) collected along the north of the Marmot Syncline. Elevation of 88 POS 30B is 2340' and the elevation for 88 POS 34A is 4060'. View is not to scale.

To the north along the Sagavanirktok River, undeformed non-marine sands of the Sagwon Member of the Sagavanirktok Formation (Paleocene to Eocene) are exposed at Sagwon Bluffs. The Sagwon Bluffs exposures are undeformed and in parts unconsolidated.

Husky Inigok Test Well #1

The Inigok Test Well #1 is located in the NE quadrant of Section 34, T8N, R5W, Umiat Meridian (70° 00'N/153° 06'W), approximately 124 miles southeast of Barrow, Alaska (Fig. 1). Drilling commenced in June 1978 and reached a total depth of 20,102 feet in the Mississippian

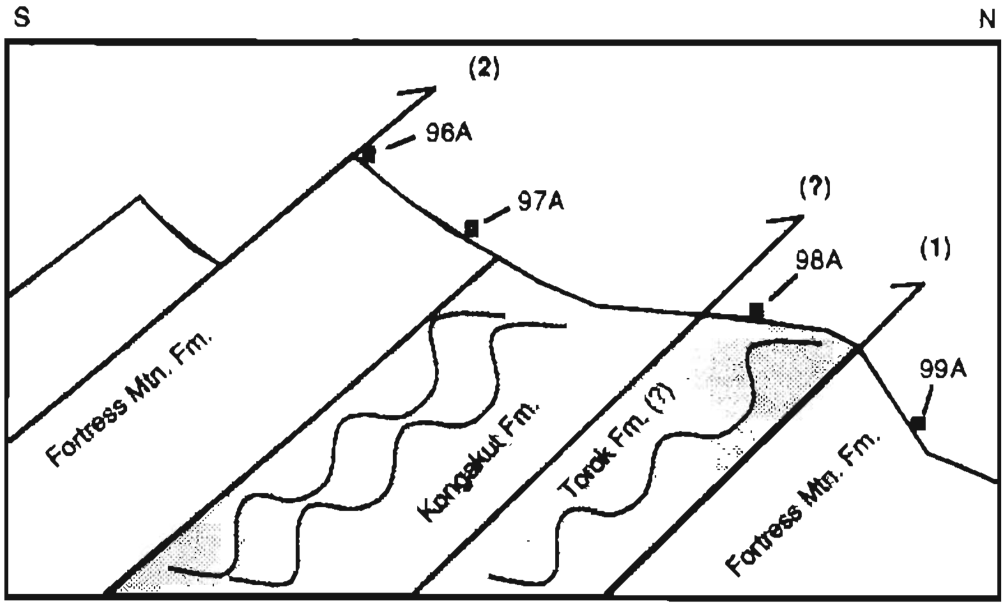


Figure 7: Cross-section of the Kongakut section showing relative positions of the four AFTA samples (89 POS 96-99) collected along the north side of the exposure east of Slope Mountain (Marmot Syncline). Elevation of 89 POS 96A is 4260' and the elevation for 89 POS 99A is 2100'. As mapped by Brosge et al (1979), the entire section, including both Kongakut and Fortress Mountain Formations, has been repeated along the fault (1). Fault (2) has repeated slabs of Fortress Mountain. Based on the AFTA data the actual location of the fault responsible for repeating the section is at the fault labeled (?), which actually separates Kongakut and Torok. This will be discussed later in the results and interpretations. View is not to scale.

Kekiktuk Formation prior to being plugged and abandoned in May, 1979. The test well, drilled in an area of very sparse subsurface control, was to test a interpreted large closure in the basal Lisbourne Group as well as test the Cretaceous "Pebble Shale" and the Triassic Sag River Sandstone. The units encountered include the Cretaceous Colville Group, Nanushuk Group, Torok Formation, and "Pebble Shale"; the Jurassic-aged Kingak Shale; the Triassic Sag River Sandstone, and Shublik Formation; the Triassic-Permian Sadlerochit Group; the Permian-Pennsylvanian Lisbourne Group; and the Mississippian Endicott Group.

<u>Husky Tunalik Test Well #1</u>

The Tunalik Test Well is located in the SE quadrant of Section 20, T10N, R36W, Umiat Meridian (70° 12'N/161° 04'W), approximately 40 miles southwest of Wainwright, Alaska (Fig. 1). The test well, drilled in an area of very sparse subsurface control, was to test a small interpreted closure on the Triassic-Permian contact. Drilling commenced in November 1978 and reached a total depth of 20,335 feet in the Lisbourne Group prior to being plugged and abandoned in January 1980. The units encountered include the Cretaceous Nanushuk Group, Torok Formation, and "Pebble Shale"; the Jurassic Kingak Shale; the Triassic Sag River Sandstone and Shublik Formation; the Triassic-Permian Sadlerochit Group; and the Permian-Pennsylvanian Lisbourne Group.

Husky Walakpa Test Wells #1 and #2

The Walakpa Test Well #1 is located in the SE quadrant of Section 9, T20N, R19W, Umiat Meridian (71° 06'N/156° 53'W), approximately 15 miles south of Barrow, Alaska (Fig. 1). Drilling of the well commenced in December 1979 and reached a total depth of 3,666 feet in argillite basement (Franklinian sequence) prior to being plugged and abandoned in February, 1980. The test well was drilled to evaluate the potential of an interpreted Upper Jurassic sandstone now determined to be Cretaceous in age and within the "Pebble Shale". The units encountered include the Cretaceous Torok Formation, and "Pebble Shale"; the Jurassic Kingak Shale; the Triassic Sag River Sandstone and Shublik Formation; and argillite basement. Data from two samples from Walakpa Test Well #2 have been projected into the vertical section from Walakpa Test Well #1 so only the history for #1 is used.

Exxon Alaska State C-1

The Exxon Alaska State C-1 well is located in the NE quadrant of Section 14, T9N, R23E (70° 08'N/146° 23'W), approximately 70 miles east of the Prudhoe Bay oil field. The well was drilled searching for "Prudhoe Bay-like" structures along the southern flank of the Barrow Arch and reached a total depth of ~13,600 in the Cretaceous Thomson Sandstone of the "Pebble Shale" prior to being plugged and abandoned. The units encountered include the Tertiary Sagavanirktok Formation; and the Cretaceous Canning Formation, Hue Shale, and "Pebble Shale".

RESULTS AND INTERPRETATIONS

Apatite fission track age analytical results and track length results for all 61 samples are given in Table 1 in Appendix A. Basic sample information, individual crystal ages, and confined track-length distributions are presented in Appendix B. The (Chi^2) χ^2 value for each sample is included as a guide to the dispersion of single-grain ages. Track-length distributions are presented for all except four samples from wells which did not contain any measurable confined tracks.

Umiat-Colville River Region

The twenty samples from the Umiat-Colville River region are divided into two groups based on areal location, stratigraphic age of the sampled unit, and apatite fission track ages: 1) an upper group of samples from the Late Cretaceous and early Tertiary sediments exposed along the Colville River; and 2) a lower group of samples from the Albian Tuktu and Torok Formations exposed south of Umiat. Eleven samples from the upper group (Fig. 3) give apatite fission track ages which range between 78.6 ± 9.4 (all age values given with 1σ errors) and 140.0 ± 16.9* Ma (* age given is the mean age due to failure of the χ^2 test). Eight samples from the lower group give apatite fission track ages from 52.9 ± 4.2 to 58.5 ± 5.9 with a mean age of ~57 Ma. One sample, 88 POS 56A from an intermediate stratigraphic interval (Albian-Cenomanian Chandler Formation), does not fit into either group, but has characteristics of both and will be discussed separately.

Apatite fission track ages (between ~79 and 140* Ma) from the individual samples from the upper group are at least as old as their stratigraphic ages (less than ~90 Ma). Of eleven samples from the upper group, seven of the samples give ages of ~90 Ma and many of the fission track ages represent multiple grain populations (see Appendix B). One of the samples from the upper group, 88 POS 52B, was collected from a tuff layer within Cenomanian shales. An age of 90.0 ± 5.0 Ma and a mean track length of 14.8 µm with a standard deviation of 1.10 were determined for this particular sample. The fission track age appears to date the volcanic event and the length distribution indicates that subsequent to deposition this sample has not been reheated to temperatures greater than ~50°C. The apatite fission track age of ~90 Ma is the same as the fission track age determined for a tuff layer from the Hue Shale (Cenomanian) exposed on the coastal plain of ANWR northeast of the Sadlerochit Mountains (O'Sullivan, 1988). This indicates volcanic deposits during the Cenomanian were deposited over a large area. Many samples from sandstone beds from the upper group also have apparent ages of ~90 Ma. This is probably due to reworking and redeposition of apatite derived from the Cenomanian tuffs.

Mean confined track lengths for the upper group range from 13.42 to 14.86, standard deviations are small (~1.0), and most of the samples have confined track length distributions indicative of rapid cooling (Fig. 8; Appendix B). The presence of a small number of shortened tracks (less than ~12 μm) indicates that these samples have experienced maximum paleo-temperatures of ~50°C since the cooling recorded by the fission track ages. Exposure to temperatures of ~50°C is supported by vitrinite values of 0.4-.5% from samples at the top of the Seabee Test Well #1 near Umiat (Magoon and Bird, 1988). Therefore, following deposition in the Late Cretaceous, the formations have not been subjected to the temperatures necessary to cause reduction or resetting of the fission track ages (temperatures greater than ~60°C), but have experienced temperatures up to ~50°C. This can be explained by burial of the present exposures to ~1.5-2 km depth (geothermal gradient = ~28°C/km) after deposition. Subsequent uplift and erosion has brought this material to the surface where it is exposed today. The AFTA data from the upper group alone does not allow for a determination of the timing of the uplift/erosion event(s) responsible for removal of the section.

Apatite fission track ages for the eight samples from the lower group (mean age ~57 Ma) are much younger than their stratigraphic ages (~100 Ma) and pass the χ^2 test. These samples have long mean confined track lengths (between 13.85 and 14.53) and small standard deviations (<1.00). The shape of the confined track length distributions are characteristic of rapid cooling (Fig. 8), from temperatures greater than ~120°C to less than ~60°C over a period of ~3-5 Ma, implying that the mean apatite fission track age for the lower group (~57 Ma) has geologic significance. The lack of shortened confined tracks indicates that the samples have not experienced temperatures greater than ~50°C since the time of cooling recorded by the fission track age. Therefore, the age and track length data indicate that the lower group of samples experienced rapid

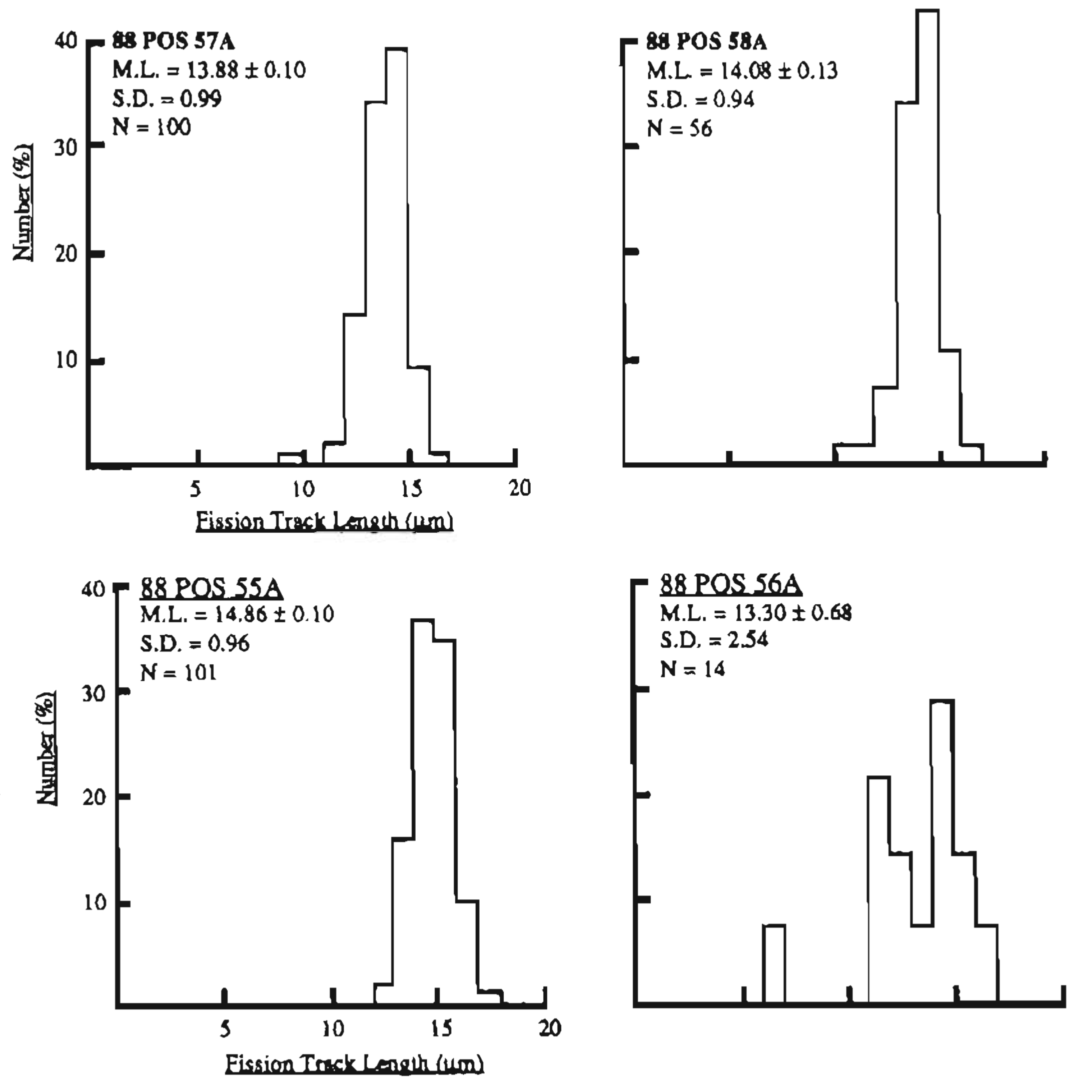


Figure 8: Representative track length data for four samples collected from the Umiat-Colville River region. Information given includes the mean length (M.L.), standard deviation (S.D.), and the number of confined tracks measured. Two samples, 57A and 58A are from Albian sediments exposed south of Umiat (lower group). A third sample, 55A, is from Tertiary sediments exposed north of Umiat (upper group). Data from all three are representative of each group. These distributions have long mean lengths and low standard deviations indicative of rapid cooling from temperatures greater than 120° to less than 60°C at the time indicated by the fission track age. The exception is sample 56A collected from Albian-Cenomanian sediments just south of Umiat. Track length data from this sample seems to show a bimodal distribution indicative of secondary heating following cooling. This is explained more in the text.

cooling at ~57 Ma ± 3 Ma, after total annealing of previously existing fission tracks and total resetting of the apatite fission track age. Subsequent to cooling at ~57 Ma, these samples have not been reheated to temperatures greater than ~50°C.

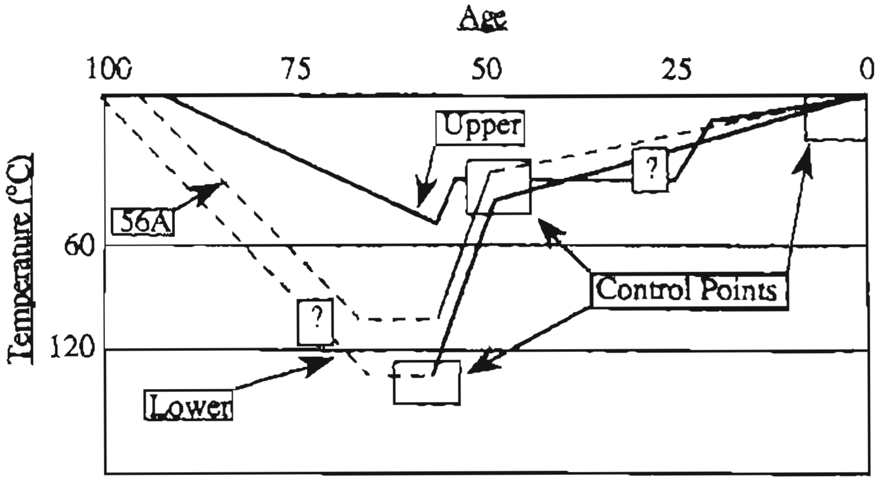


Figure 9: Proposed thermal history, using AFTA, for the samples collected from the Umiat-Colville River region. Control points indicate regions where the AFTA data places constraints on the temperature-time paths. The time-temperature path for the lower group shows burial to temperatures greater than 120°C followed by a rapid cooling event at ~57 ±3 Ma. The upper group was buried to ~1.5-2 km and achieved temperatures of ~50°C prior to uplift/erosion to the surface. This uplift could have occurred during the Paleocene, or during the Miocene (based on data from the Inigok Test Well #1 explained in the text). Sample 56A, located stratigraphically between the previous two groups records an intermediate history with a substantial amount of thermal annealing resulting in age reduction from ~90 Ma (stratigraphic age) to below 70 Ma (F.T. age).

Figure 9 shows the proposed time/temperature paths determined for the Umiat-Colville River region after modelling and interpretation of the AFTA data obtained from that area. Following deposition of the Albian sediments, from which the lower group of samples were collected, they were buried under a thick package of Late Cretaceous rocks (greater than 4 km) resulting in raising of temperatures to greater than ~120°C and resetting of their apatite fission track ages. Subsequently, as determined by the AFTA results from the lower group, rapid cooling (due to uplift and erosion?) occurred at ~57 ± 3 Ma. This phase of cooling was recorded by apatites from the Albian sediments as ~4 km of Late Cretaceous sediments were rapidly eroded, resulting in exposure of the Albian sediments within the cores of anticlines along the foothills. The AFTA data from the Late Cretaceous sediments to the north, from which the upper group of samples was collected, reflect the thermal histories of the samples' source terranes. Following deposition, this region has not been buried deeply enough to experience temperatures necessary to substantially reduce the mean confined track lengths below ~14 μm. The presence of a small percentage of shorter tracks indicates that after deposition these sediments experienced maximum paleotemperatures of ~50°C (1.5-2 km of burial). Subsequent uplift and erosion has brought these sediments to the surface.

Since data from the upper group of samples do not control the time over which cooling due to uplift/erosion occurred within the Umiat-Colville River region, there are two possibilities as to when this phase of cooling occurred: 1) due to the close proximity of the Late Cretaceous sediments to the Albian sediments, and the lack of a "structural break" between the two localities, it is possible that after reaching maximum depths of burial and maximum paleotemperatures during the early Paleocene, the entire Umiat-Colville River region was uplifted at ~57 Ma; or, and more likely, 2) incorporating interpretations of data from the Inigok Test Well #1 (this report), located ~60 km north of Umiat, which show ~0.5-1 km of uplift/erosion of the section at ~20-25 Ma, it is possible that the section north of Umiat experienced cooling due to uplift/erosion at ~20-25 Ma.

Interpretations of fission data from many localities across northern Alaska have reported the mechanism for rapid cooling events recorded by the AFTA data are most likely due to changes in the position of paleo-isotherms in response to uplift and erosion (O'Sullivan, 1988; O'Sullivan et al., 1989 and 1990a, b, and in prep). It is therefore postulated that the rapid cooling recorded in the Umiat-Colville River region during the Paleocene is also due to uplift/erosion. AFTA data from other outcrop localities along the northern flank of the Brooks Range including Slope Mountain (O'Sullivan, 1989b, and this report), Fortress Mountain (O'Sullivan, 1990a), along Gilead Creek (unpublished preliminary results), and Bathtub Ridge (O'Sullivan, 1988) indicate this Paleocene uplift and erosion event is of regional significance.

Figure 9 also shows the complicated time/temperature history for sample 88 POS 56A, (late Albian), which stratigraphically overlies the lower group and underlies the upper group. The track length distribution for this sample shows a bimodal distribution which is characteristic of a secondary heating event (Gleadow et al. 1983). Following deposition (~95 Ma), 56A was deeply buried under the sediments of the upper group, but not as deeply as those of the lower group, prior to rapid cooling due to uplift and erosion at ~57 Ma. This interpretation explains why the apatite fission track age was reduced from ~90 Ma to ~68 Ma, but not totally reset, and why sample 56A has a bimodal track length distribution. Modelling of these data indicates the sample reached a maximum of ~100°C and a depth of burial of ~3.5 km (assuming a ~28°C/km geothermal gradient) prior to cooling in the Paleocene.

Sagavanirktok River Region

The thirteen samples from the Sagavanirktok River region include samples from the Albian-aged Fortress Mountain Formation, Kongakut Formation and Nanushuk Group (Tuktu, and Chandler Formations) exposed along two vertical sections near Slope Mountain (Fig. 4) and a single sample from the 'Icecut', as well as those from the early Tertiary sediments exposed along Sagwon Bluffs (Fig. 5).

Five samples from the Nanushuk Group exposed at the "Slope Mountain section" (Fig. 10) give apatite fission track ages from 41.4 ± 5.0 Ma to 58.5 ± 8.3 Ma (mean age = ~50 Ma). A single sample from the Tuktu Formation exposed at the Icecut gives an apatite fission track age of 44.4 ± 4.3 Ma. All six apatite fission track ages from the Slope Mountain section and the Icecut are much younger than their stratigraphic ages (~100 Ma) and pass the χ^2 test, indicating that the individual grain ages represent a single age population. These six samples have mean confined track lengths from 13.68 to 14.30 μm and standard deviations between 1.33 and 2.30 with a trend of increasing mean confined track length and decreasing standard deviation downsection. In general, the track length distributions for these samples exhibit a strong peak at ~13-14 μm, with the mean length around ~13 μm, and a small percentage of short tracks less than 10 μm (Figs. 10 and 11). The decrease in mean length from initial length of ~14.5 μm to ~13 μm indicates slight shortening of existing tracks due to heating after the time recorded by the fission track age. The presence of a small percentage of short tracks in such a distribution can be explained by: (A) severe, but not

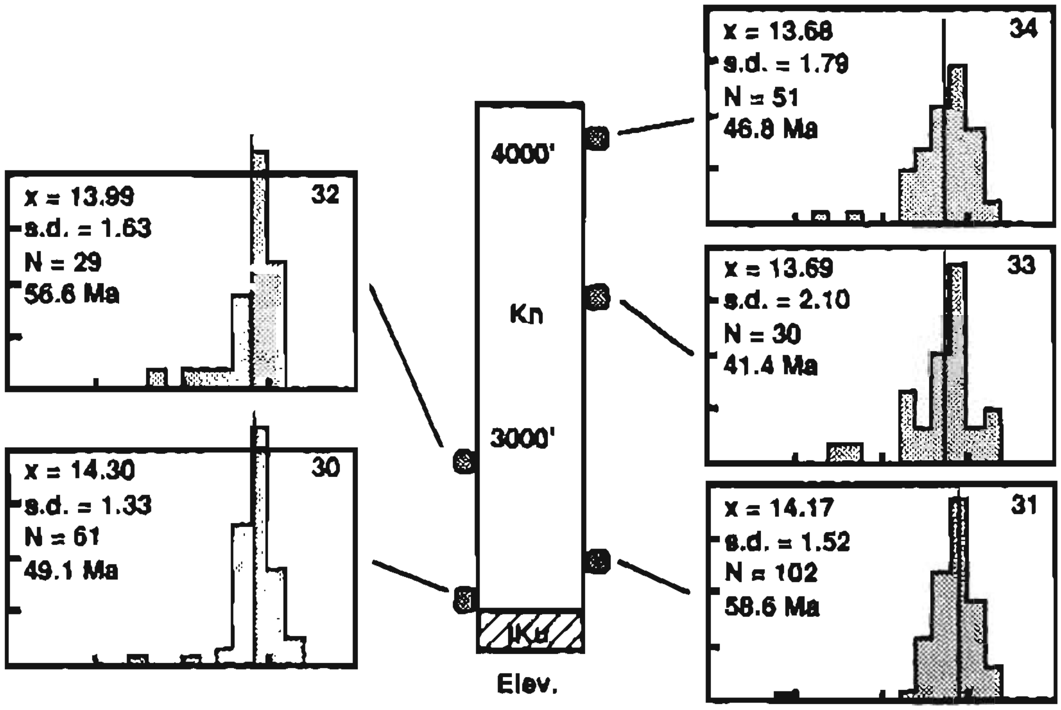


Figure 10: AFTA data for the samples collected from the Slope Mountain section. Information given includes the sample number (88 POS 30-34), mean length (x), standard deviation (s.d.), the number of confined tracks measured (N), and the apatite age. The mean track length is shown by the vertical line.

total, annealing of older tracks at temperatures below that required for total annealing; or (B) slow cooling following total annealing. Explanation (B) can be the result of a longer period of cooling from 120° to 60°C over ~8-10 Ma, with the shorter tracks representing those which formed within this temperature range; or as the result of two phases of cooling, with the shorter tracks remaining from an earlier phase which cooled the section to temperatures between ~120°-100°C prior to a later rapid cooling. Because the apatite fission track ages are much less than the stratigraphic age for the sediments and the shape of the confined track length distributions are indicative of rapid cooling after deposition, the samples must have been heated to temperatures greater than 120°C to totally anneal existing fission tracks. This was followed by cooling prior to a second minor phase of heating to temperatures less than ~40-50°C, and then final cooling to present surface temperatures.

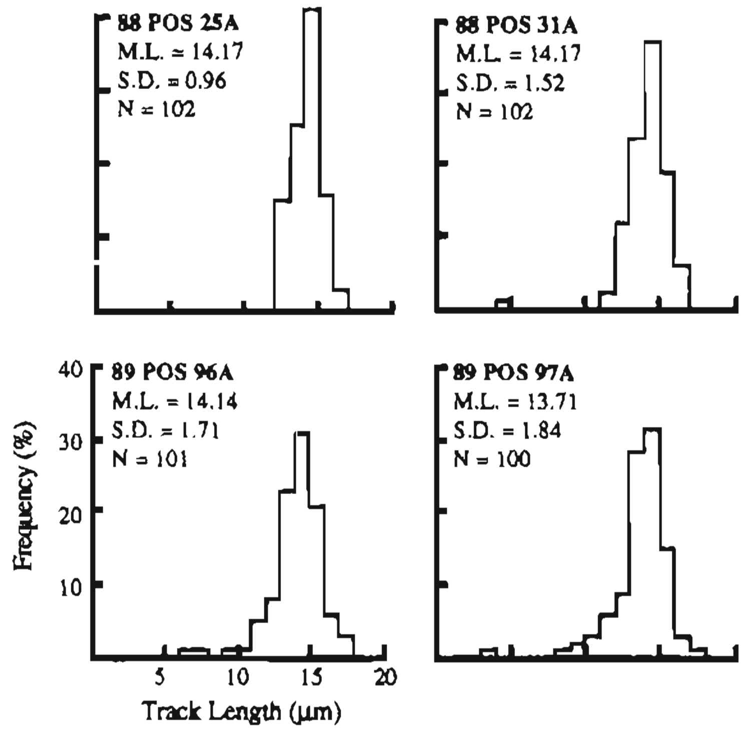


Figure 11: Track length data for four representative samples collected from the Sagavanirktok River region. Information given includes the mean length (M.L.), standard deviation (S.D.), and the number of confined tracks measured (N). Sample 25A is from the Sagwon Member of the Sagavanirktok Formation exposed along the Sagavanirktok River at Sagwon Bluffs. Sample 31A is from the Tuktu Formation at Slope Mountain, and Samples 96A and 97A are from the Kongakut section. All samples have long mean lengths with small standard deviations indicative of rapid cooling. The smaller standard deviations represent more rapid cooling. In terms of cooling rates, 25A cooled through 120-60°C in 3-5 Ma while the other samples cooled through 120-60°C in 5-8 Ma. This is explained more in the text.

Four samples from the Albian Fortress Mountain and Kongakut Formations exposed at the "Kongakut section" give apatite fission track ages which range between 44.9 ± 3.0 and 68.7 ± 12.3* Ma (Fig. 12; * age given is the mean age due to failure of the χ^2 test). The three samples from the Fortress Mountain Formation pass the χ^2 test, indicating that they represent a single grain-age population, and have a mean age of ~49 Ma. This mean age is much younger than the stratigraphic age of ~100 Ma. The fourth sample (89 POS 98A), from the Kongakut Formation sandwiched between two beds of Fortress Mountain Formation (Figs. 7 and 12), does not pass the χ^2 test, so the mean age represents multiple grain-age populations. The sample fails the χ^2 test because of the presence of a few precise older grains which the other samples from the section do not have (see Appendix B). This indicates that while apatite fission track ages from the Fortress Mountain Formation in this section have been totally reset due to exposure to temperatures greater than ~120°C, the Kongakut Formation has not seen the same high temperatures and the apatite fission track have ages not been totally reset. This will be discussed in more detail later.

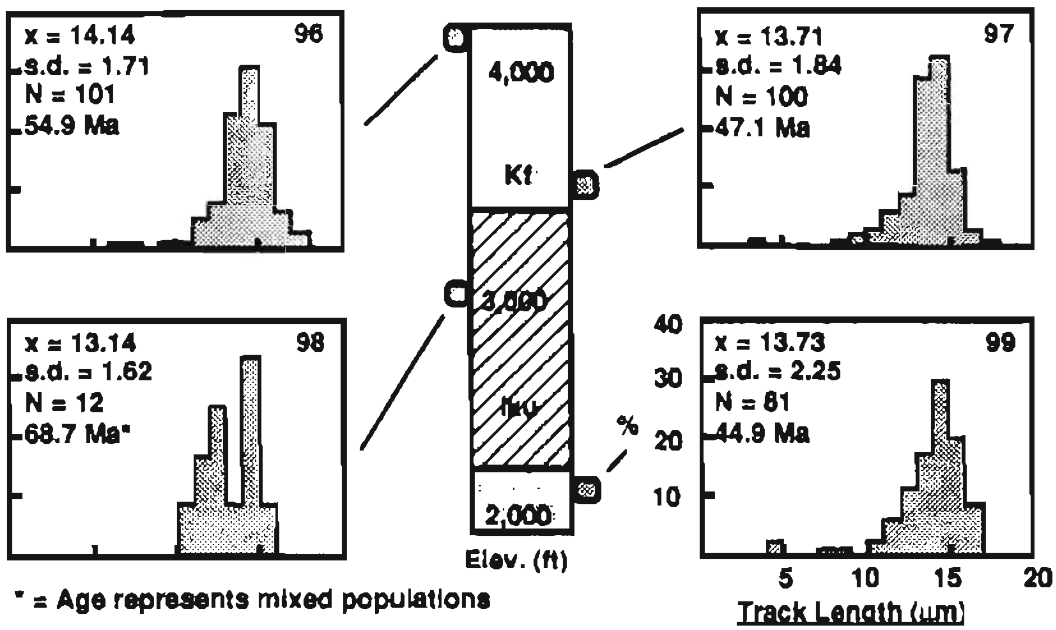


Figure 12: AFTA data for the samples collected from the Kongakut section. Information given includes the sample number (89 POS 96-99), mean length (x), standard deviation (s.d.), the number of confined tracks measured (N), and the apatite age.

The four samples from the Kongakut section have mean track lengths between 13.14 and 14.14 and standard deviations from 1.62 to 2.25. The distribution for each sample contains a strong peak at ~13-14 µm as well as a distinct "tail" of shorter tracks less than ~12 µm (Fig. 11). Because the apatite fission track ages for samples from the Fortress Mountain Formation (~47 Ma) are much less than their stratigraphic age (~100 Ma) and the shape of the confined track length distributions are indicative of rapid cooling following deposition, the samples must have been heated to temperatures greater than 120°C to totally anneal existing fission tracks. This was followed by cooling prior to a second phase of heating to temperatures less than ~40-50°C and subsequent cooling to present surface temperatures. During the first heating event, the "Kongakut" sample experienced maximum paleo-temperatures of ~100°C, which were not high enough to totally anneal the fission tracks.

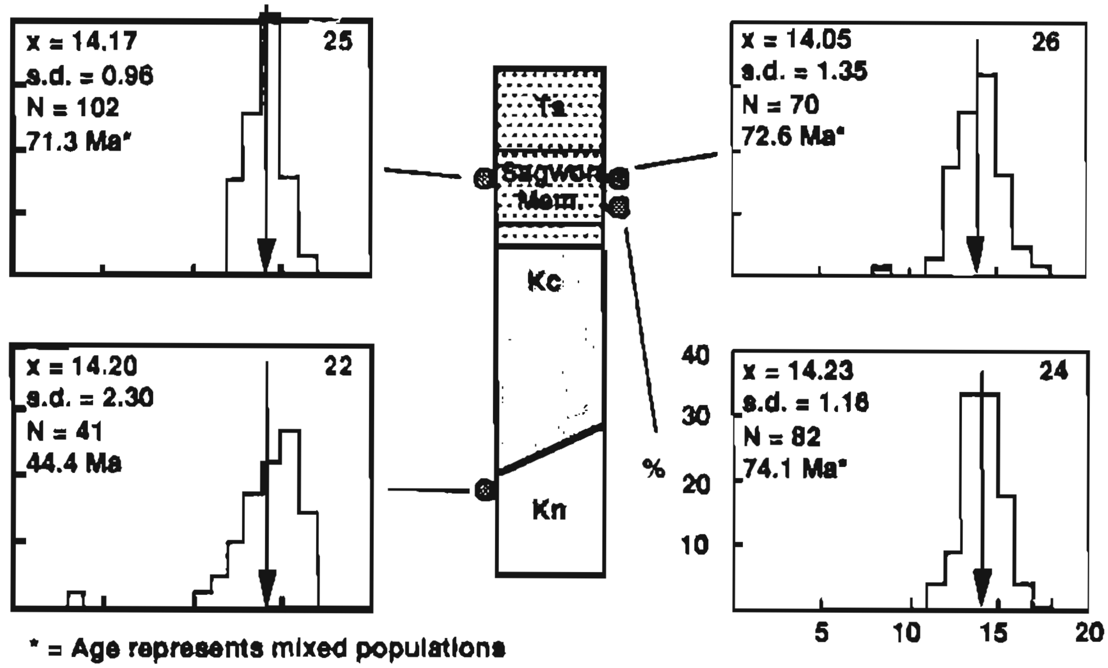


Figure 13: AFTA data for the samples collected from Sagwon Bluffs and the Icecut (#22). Information given includes the sample number (89 POS 22-26), mean length (x), standard deviation (s.d.), the number of confined tracks measured (N), and the apatite age. The mean track length is shown by the vertical line.

Further north in Late Eocene deposits exposed at Sagwon Bluffs, apatite fission track ages range between 71.3 ± 14.1* and 74.1 ± 19.2* Ma (Fig. 13). The mean confined track lengths for the samples from Sagwon Bluffs are all long (>14 μm) with standard deviations between 0.96 and 1.35, both indicative of very rapid cooling. Unlike those from the Albian sediments, ages from the individual samples collected from the Eocene sediments at Sagwon Bluffs are older than, or indistinguishable (within error) from their depositional ages (~50 Ma). Therefore, subsequent to deposition, these samples have not been subjected to temperatures necessary to cause accelerated annealing of fission tracks (greater than ~60°C). The presence of a few shortened tracks in a couple of the samples could indicate that these samples may have been reheated to ~40°C after deposition.

Figure 14 shows proposed time-temperature paths experienced by the different areas, determined by modelling and interpretation of the fission track data from the Sagavanirktok River region. Within the limitations of the data, it is possible to delineate two cooling events for both the Slope Mountain and Kongakut sections. From these two sections the shape, mean length, and standard deviations for the confined track length distributions are indicative of rapid cooling from temperatures greater than 120 to less than 60°C over periods of between 5-8 Ma during the Paleocene, followed by a later phase of heating and cooling. To explain resetting of the apatite fission track ages from both the Slope Mountain and Kongakut sections, it is believed that the sections were buried under a thick package of Late Cretaceous rocks (greater than ~4 km). Burial resulted in raising of temperatures to greater than ~120°C. This was followed by rapid cooling, due to uplift and erosion, on the order of 2-2.5 km at ~52 ± 4 Ma (Fig. 14). The 52 Ma age reflects a corrected mean age for the samples from both vertical sections after the effects of annealing (seen by the shortened tracks) are removed. The rapid cooling at ~52 Ma recorded within both vertical sections is believed to be a result of uplift and erosion, due to thrusting south of the structural boundary now separating uplifted and deformed sediments exposed at the Slope Mountain and Kongakut sections from undeformed Sagwon Bluff sediments.

With the data presented in this report it is not possible to determine the timing of the second cooling phase. However, a 20 Ma uplift and denudation event has been proposed by O'Sullivan (1988) and O'Sullivan et al. (in prep) on the basis of AFTA data from ANWR and from possible crustal relaxation in the Inigok Test Well #1 (this report). To explain the AFTA data presented herein, uplift and erosion resulting from the event at ~20 Ma was about ~1 km.

AFTA gives little control on the thermal history of the samples to the north, at the Sagwon Bluffs. However, since this area may have been buried to ~40°C after deposition (~1.5 km with a geothermal gradient of ~28°C/km), it is assumed that the Sagwon Bluffs section experienced the same Miocene cooling seen elsewhere in the region (Fig. 14). To produce the observed confined track length distributions for these samples, rapid cooling was necessary, but must have occurred in the source area prior to erosion and redeposition. This indicates the ages and track lengths reflect

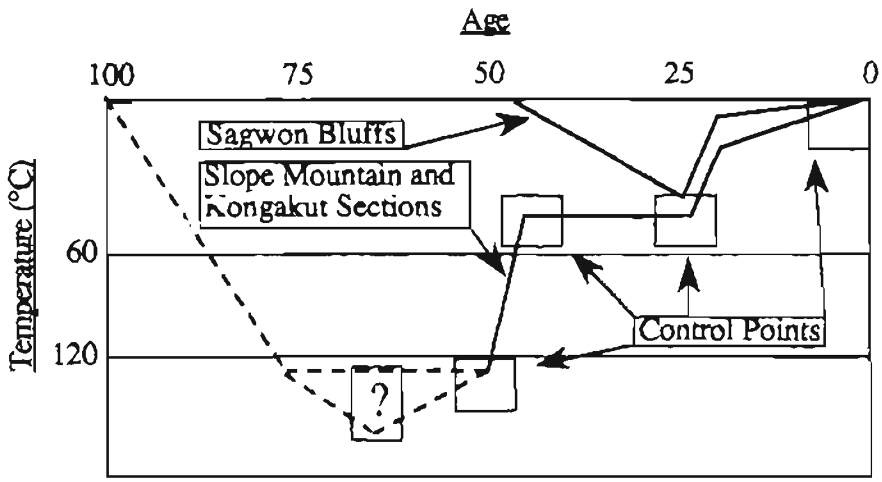


Figure 14: Proposed thermal history for the samples collected from Slope Mountain section, the Kongakut section, and at Sagwon Bluffs along the Sagavanirktok River. The time-temperature path for Slope Mountain (including a sample from the Icecut) shows two periods of cooling at ~ 52 and ~20 Ma. The timing of the second event is inferred from regional results from O'Sullivan et al. (in prep).

the thermal histories of the samples' source. Due to the large percentage of individual grain ages of ~50-60 Ma (see Appendix B), it is believed that a major rapid cooling event occurred at ~50-60 Ma in the source terrane for the Sagwon Bluffs. It is possible that material eroded from the Slope Mountain and Kongakut sections during uplift could have been redeposited in the Sagwon Bluffs.

To further complicate the issue, at the time of thrusting (~52 Ma), the Kongakut section was repeated along a detachment surface within the Kongakut Formation. By using the stratigraphy as mapped by Brosge et al. (1979), it is not possible to explain how samples from the Fortress Mountain Formation can be totally reset while the sample from the underlying Kongakut Formation can be unreset. Therefore it is proposed that the detachment surface responsible for repeating the section actually cut up-section from the underlying Kongakut Formation, through the Fortress Mountain Formation, and leveled out in the overlying Torok Shale (Fig. 15). This is a possible explanation of how the shale layer, which has not been reset, can be sandwiched between two layers of reset Fortress Mountain Formation.

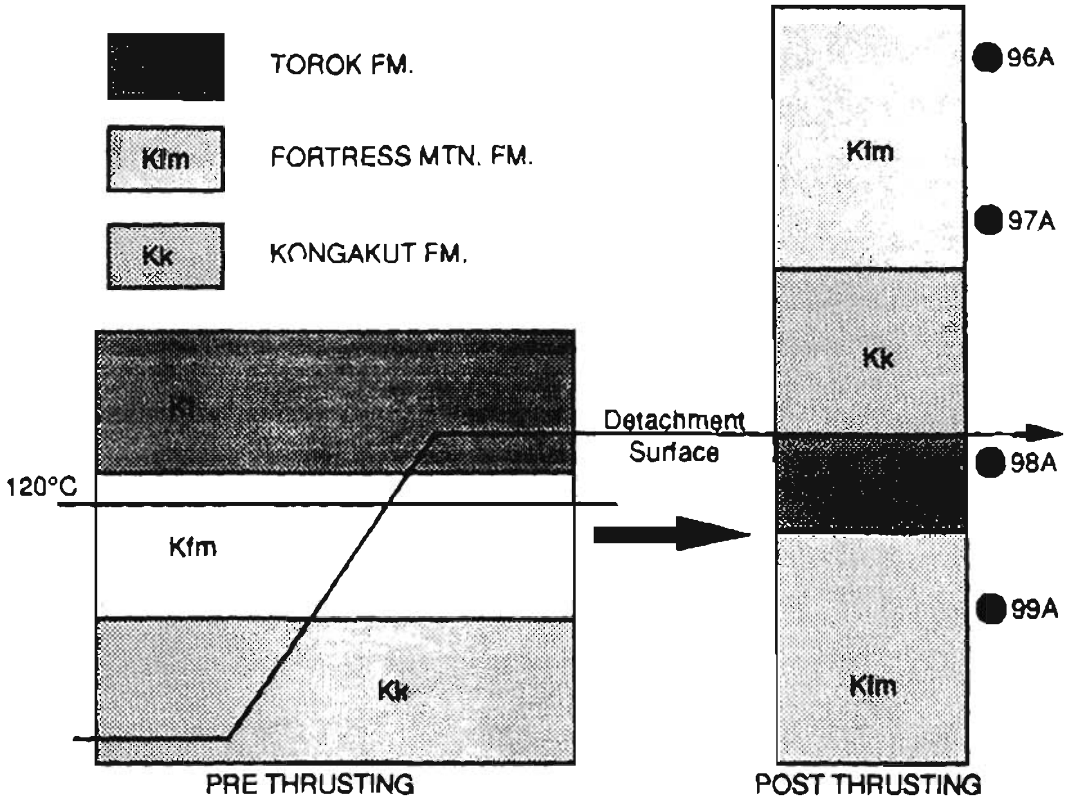


Figure 15: Proposed thrust relationship for the samples collected from the Kongakut section. During the Albian, the Kongakut Formation, the Fortress Mountain Formation, and the Torok Formation were deposited in a continuous sequence. Thrusting then occurred during the Paleocene along a detachment surface which cut upsection from the Kongakut Formation through the Fortress Mtn. Formation and leveled out in the Torok Formation. The resulting section contains a small sliver of Torok Formation at the top of the lower slab of Fortress Mtn. Formation.

Husky Inigok Test Well #1

The data for the Inigok Test Well #1 include nine samples from the Albian Nanushuk Group and Torok Formation, Jurassic Kingak Shale, Triassic Ivishak Formation, Permian Echooka Formation and the Mississippian Kekiktuk Conglomerate. In the Inigok #1 well, apatite fission track ages decrease from 97.6 ± 9.5 Ma at estimated present temperatures of ~20°C, in the Albian rocks sampled at ~2,600' (790 m), to ~0 Ma ages at estimated present temperatures of ~120°C below the Ivishak Formation at ~13,000' (3,940 m; Fig. 16). These estimates of present temperature are determined using a geothermal gradient of ~30°C/km for the Inigok well reported by Blanchard and Tailleur (1982). The loss of fission tracks in apatite at estimated temperatures greater than ~120°C

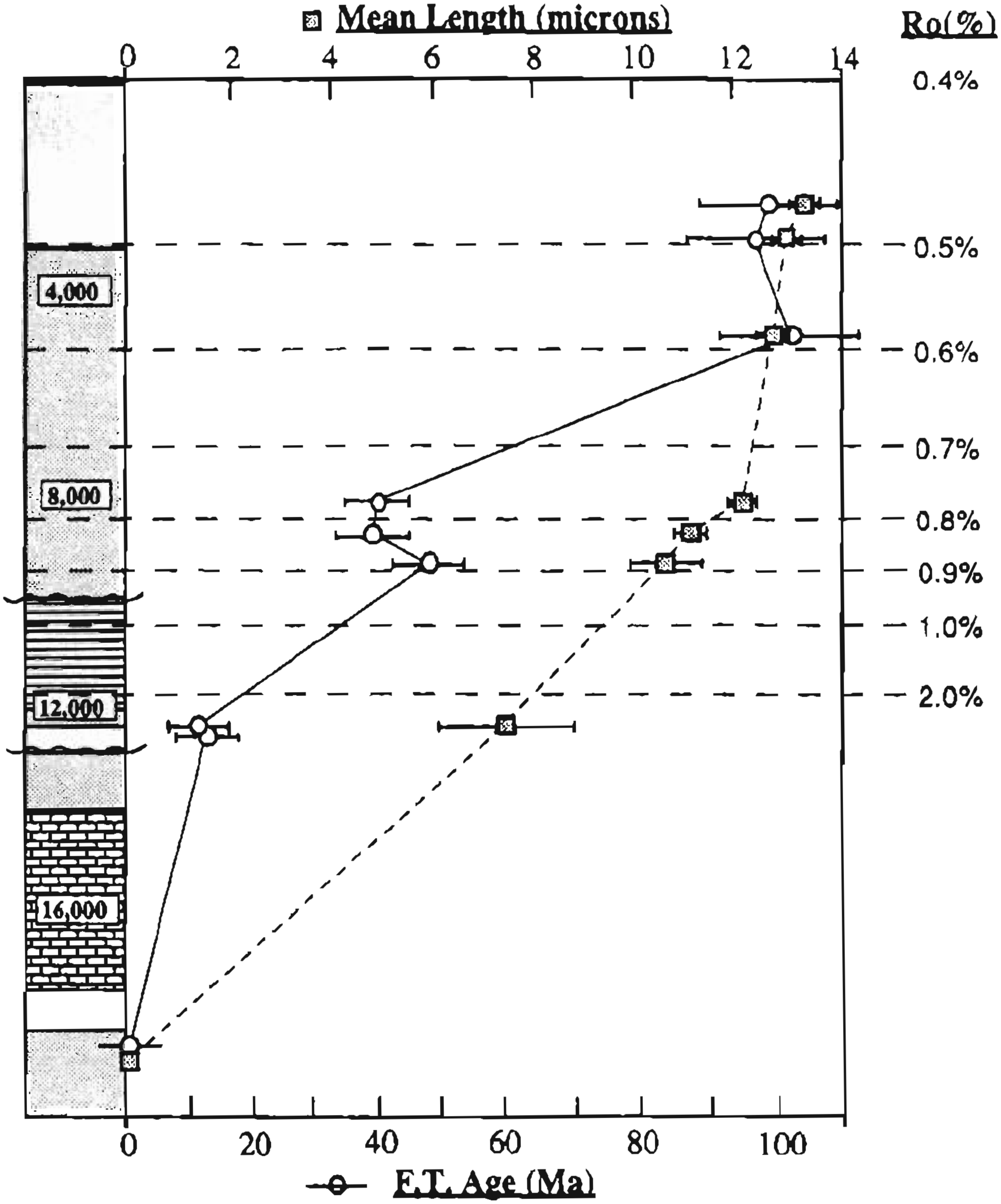


Figure 16: Relationship between depth, apatite fission track age, mean confined track length, and vitrinite reflectance values determined for the Husky Inigok Test Well #1. Aspects concerning these relationships are discussed in the text.

in the Inigok well indicates a value of ~30°C/km for the geothermal gradient is consistent with the fission track parameters. Mean track lengths decrease from ~13.4 μm (from 88 POS 127A in the

Nanushuk Group) to a low of 7.6 µm (from 88 POS 119A in the Ivishak Formation). One sample (88 POS 117A), collected from below the Ivishak, yielded apatite but did not contain any confined tracks.

The AFTA data clearly indicate exposure to elevated paleotemperatures subsequent to deposition. Three samples from the upper part of the well (upper group), from the Nanushuk Group and Torok Formation between ~2,600'-~5,000', give apatite fission track ages ranging from ~102 to ~98 Ma, which are indistinguishable from their depositional ages (~95-105 Ma). The mean track lengths from samples within this group (present temperatures from ~20-45°C) have been shortened slightly to less than 14 µm, implying that at some time the apatites experienced temperatures up to ~70°C which resulted in minor track shortening and some degree of age reduction. Since this maximum temperature is consistent with the temperatures estimated from the vitrinite values listed for the well (Fig. 16), it is believed that these temperatures were experienced after deposition and are not inherited from the source terranes. Therefore annealing of these samples must have occurred at elevated paleotemperatures at some time in the past and, since deposition, the upper part of the well records a minimum amount of cooling from ~70°C to less than 45°C. Assuming a geothermal gradient of ~30°C/km for the well, a minimum of 3,500-5,000' (1-1.5 km) of section has been removed by erosion.

Pooled fission track ages from the three samples collected from the Torok Formation and Kingak Shale between ~8,200' and ~9,400' (middle group) range from ~50 to ~39 Ma. This large decrease in fission track age between the upper and the middle groups occurs over a 3,200' interval (~30°C) and identifies the paleo-break between sediments in which apatite ages were not totally reset (upper group) and those whose apatite fission track ages were totally reset before cooling to present temperatures (middle group). The degree of age reduction, from depositional ages greater than ~100 Ma to apatite fission track ages less than 50 Ma, seen in these three samples is much more than can be explained purely by burial to present maximum temperatures. Vitrinite values for the section (Ro = ~0.8%; Bayliss and Magoon, 1988) also show evidence for paleotemperatures greater than 130°C. Therefore, the middle part of the section experienced cooling from ~130°C to ~75-85°C and erosion of at least 3,500-5,000' (1-1.5 km) of section.

Pooled fission track ages in the three deeper samples in Inigok #1 continue to decrease from ~13 Ma to 0 Ma as the present temperature increases from ~85 to greater than 180°C. Two samples from the Ivishak Formation at ~12,500-12,700' (present temperature ~115°C) have apatite fission track ages of ~12-13 Ma. Only one of these samples (88 POS 119A) contained any length measurements (~7.5 µm).

Corrected ages for the middle group of samples are between ~50 and ~60 Ma, compared to stratigraphic ages between ~105 and ~160 Ma, suggesting that these samples were totally annealed then cooled in the Paleocene from paleotemperatures greater than 110°C. This is supported by the individual grain ages for the samples which show that most grains have ages of ~60 Ma or less. The apatite age for the sample from the Ivishak Formation (~11.7 Ma) is corrected back to ~21 Ma and most of the individual grain ages for both Ivishak samples are ~20 Ma or less.

Modelling of the confined track length distributions in each sample and the patterns of apatite ages with depth supports two phases of cooling, the first being in the Paleocene and the second during the Miocene (Fig. 17). The initial heating during the Paleocene (~55-60 Ma) caused the section above ~10,000' (~3,000 m) to cool from paleotemperatures greater than 120°C to ~50-60°C. Based on the modeling, it is estimated that ~1.5-2 km of uplift occurred during this phase prior to subsequent reheating of approximately ~25-35°C (~1km of burial). A later phase of cooling (~15-25°C; ~0.5-1 km) which began in the Late Tertiary (~20-25 Ma) caused the section between ~10,000 and 13,000' (~3,000-4,000 m) to cool to ~100°C from paleotemperatures greater than 120°C. The exact timing of the second event is difficult to control with the sparse data, but ~15-25 Ma would be acceptable. Both phases of cooling (a minimum of ~30-45°C) occurred as a result of 1-1.5 km of uplift and erosion of the stratigraphic section.

Husky Tunalik Test Well #1

The data for the Husky Tunalik Test Well #1 include eight samples from the Albian Nanushuk Group and Torok Formations, Jurassic Kingak Shale, Triassic Ivishak Formation and Sag River

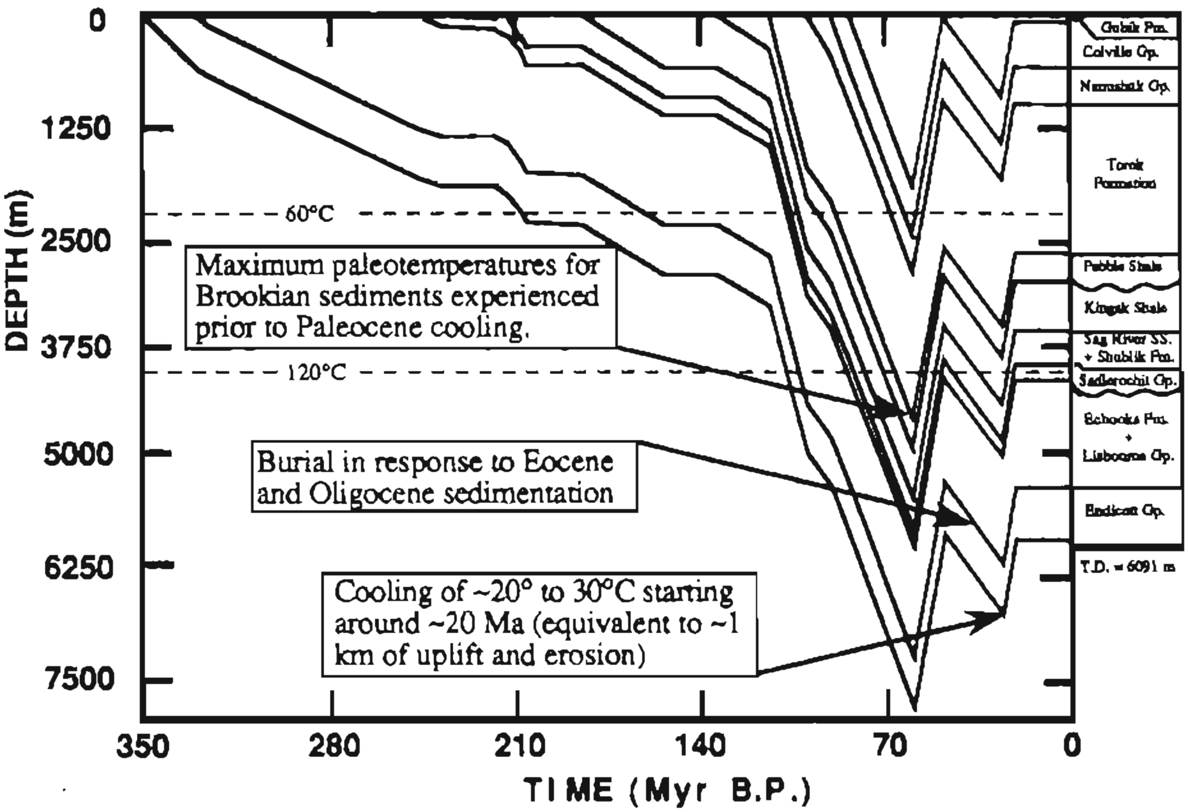


Figure 17: Lopatin diagram showing proposed depositional history for the Husky Inigok Test Well #1. Based on fission track and vitrinite parameters the well reached maximum paleotemperatures due to burial in the Late Cretaceous-Paleocene. This was followed by two phases of cooling due to uplift/erosion: the first in the Paleocene at ~60 Ma; and the second during the Miocene at ~20 Ma.

Sandstone, and the Permian Echooka Formation. In Tunalik #1, apatite fission track ages decrease from 80.3 ± 6.7 Ma at estimated present temperatures of ~34°C in the Nanushuk Group rocks at ~3,300'(1,000 m), to ~0 Ma ages at estimated present temperatures of ~158°C below ~15,400' (~4,650 m) in the Echooka Formation (Fig. 18). These estimates of present temperature are determined using a geothermal gradient of ~34°C/km for the Tunalik #1 well reported by Blanchard and Tailleur (1982). Mean track lengths decrease downhole from 13.9 µm in the Nanushuk Group to a low of 7.4 µm from the Ivishak Formation One sample (88 POS 100A) yielded apatite but no confined tracks.

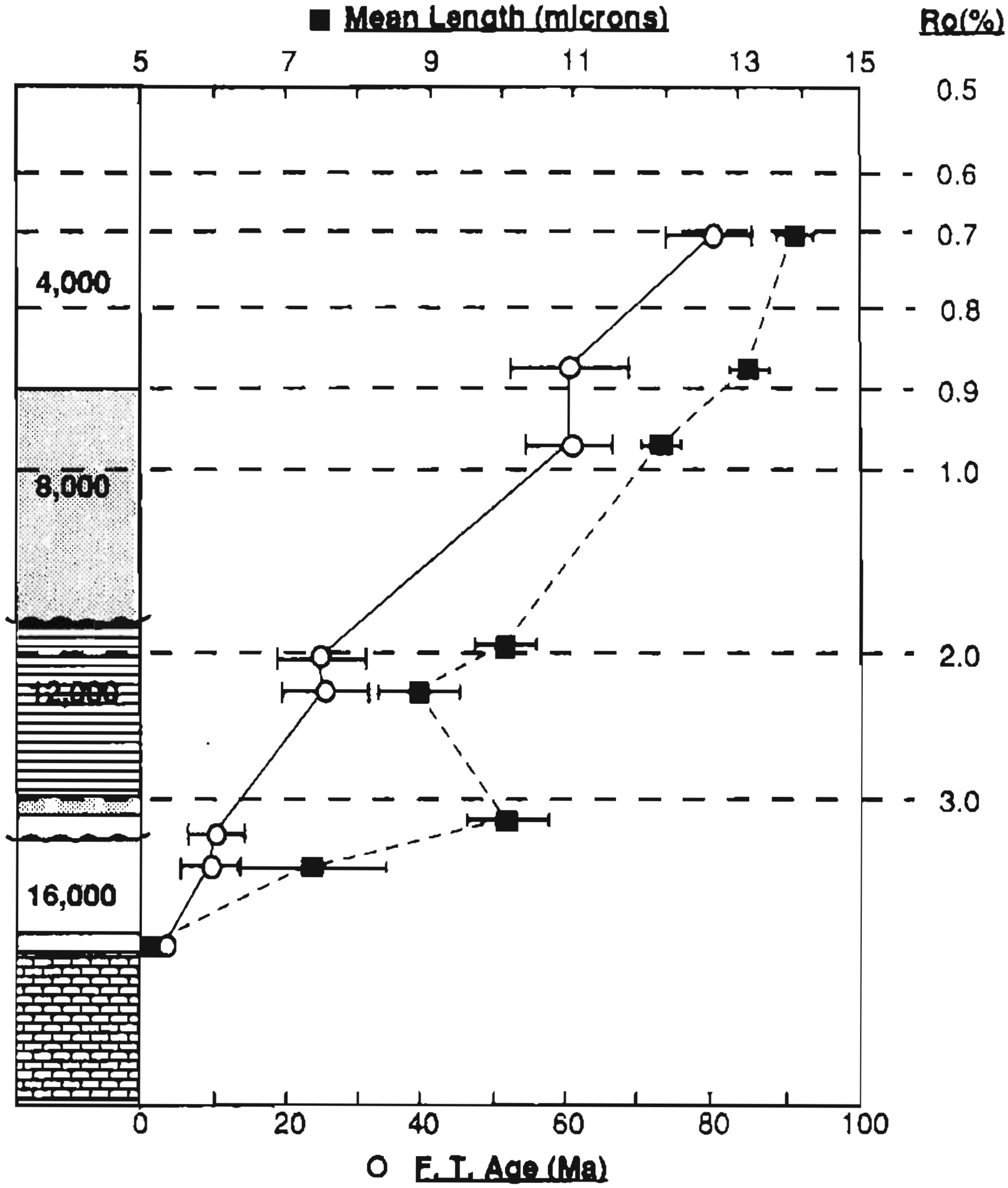


Figure 18: Relationship between depth, apatite fission track age, mean confined track length, and vitrinite reflectance values determined for the Husky Tunalik Test Well #1. Aspects concerning these relationships are discussed in the text.

Two samples, 88 POS 99A and 102A from the Ivishak Formation and the Sag River Sandstone respectively, have fission track ages and confined track lengths at estimated present temperatures of ~155°C. The occurrence of fission tracks at temperatures above ~120°C is unusual and suggests that either the section has reached present temperatures very recently (ie. within the last ~1 Ma) or the present temperature estimate is incorrect. It is believed that the latter is more likely, given that: 1) there is no evidence regionally that a large increase in geothermal gradient has occurred very recently; and 2) only at depths greater than ~14,500' do Blanchard and Tailleur (1982) report temperature values consistent with geothermal gradients greater than ~30°C. On the basis that all fission tracks in apatite should be annealed at present temperatures greater than ~110-120°C, a value for the geothermal gradient of ~25°C/km is consistent with the fission track data. This value of 25°C/km has been used when modelling the age and length parameters.

As with the Inigok #1 well, the AFTA data for the Tunalik #1 well clearly indicates that the entire sequence has been exposed to elevated paleotemperatures after deposition. As shown by the vitrinite values for the Tunalik #1 well (R_o = 0.5% at the surface, 0.7% at ~3,300', and 1.0% at ~7,800'; Fig. 18), these paleotemperatures are higher than those experienced by the Inigok #1 section (Ro = 0.4% at the surface, 0.7% at ~7,000', and 1.0% at 10,500'). This translates to a difference of ~1 km of section between the two wells, with the Tunalik #1 section having experienced higher paleotemperatures than the equivalent section in Inigok #1.

In the Tunalik #1 well, there is a distinct break in apatite fission track ages within the Nanushuk Group from an age of ~80 Ma at ~3,300' (1,000 m) to ages of ~61 Ma at ~5,600' and 6,500' (1700 and 2,000 m). The ~80 Ma pooled fission track age and the majority of individual grain-ages for the upper sample are significantly less than the depositional age (~100 Ma) and the mean confined track length is ~14 μm (standard deviation of 1.22). Possible explanations of the age and length data are: either this sample experienced rapid burial to depths with temperatures high enough to totally reset the apatite fission track age prior to rapid cooling at ~80 Ma; or after deposition the sample has not experience temperatures greater than ~70°C for any length of time, which would have substantially shortened the mean confined track length. The vitrinite values reported for the Tunalik well by Bayliss and Magoon, (1988) (Fig. 18), indicate that the sample (at ~1 km depth) has experienced maximum temperatures of ~120°C (R_o = 0.7%). Therefore the apatite fission track age has been totally reset prior to cooling in the Late Cretaceous. Furthermore, after reaching its maximum paleotemperature of ~120°C in the Late Cretaceous, the sample has experienced ~90°C of cooling (120°-25°C) corresponding to ~3.5 km of uplift and erosion.

In the middle of the downhole section, pooled fission track ages from samples between ~5,600' and ~11,700' (present temperatures between ~42-90°C) drop dramatically from ~61 Ma to ~25 Ma. Corrected ages for this group are between ~76 and 68 Ma, compared to stratigraphic ages from ~105 to ~113 Ma. This drop in age is consistent with increased track annealing at temperatures between ~60°-120°C after cooling from paleotemperatures greater than 110°C in the Late Cretaceous. This is supported by the individual grain ages for the samples which show that most grains have ages of ~80 Ma or less. The apatite fission track ages for the samples from the Ivishak Formation and the Sag River Sandstone. (~8.5-10 Ma) can be corrected back to ~19 Ma and most of the individual grain ages for both samples are ~20 Ma or less.

Modelling the confined track length distributions in each sample and the patterns of apatite ages with depth support two phases of cooling with the first being in the Late Cretaceous and the second during the Miocene (Fig. 19). Following deposition, the section was buried to depths where temperatures necessary to totally anneal the entire sampled section occur. The initial phase of cooling began in the Late Cretaceous (~80-85 Ma) resulting in the top of the section cooling a total of ~70-80°C from paleotemperatures greater than 120°C. Based on modeling, it is estimated that ~3 km of uplift/erosion occurred during this phase. After this initial phase of cooling, the lower part of the section (samples 88 POS 99A, 100A, and 102A) remained at temperatures greater than 110°C. A second phase of cooling (~15-25°C) corresponding to ~0.5-1 km of uplift/erosion began in the Late Tertiary (~20-25 Ma) and resulted in cooling of the lower part of the section (~14,800-15,400') from paleotemperatures greater than ~120°C to ~90°-100°C. The exact timing of this second cooling event is difficult to control with the sparse data, but ~15-25 Ma would be compatible. The combined effect of both phases of cooling (a total of ~80-95°C) resulted in ~3-3.5 km of uplift/erosion of the stratigraphic section.

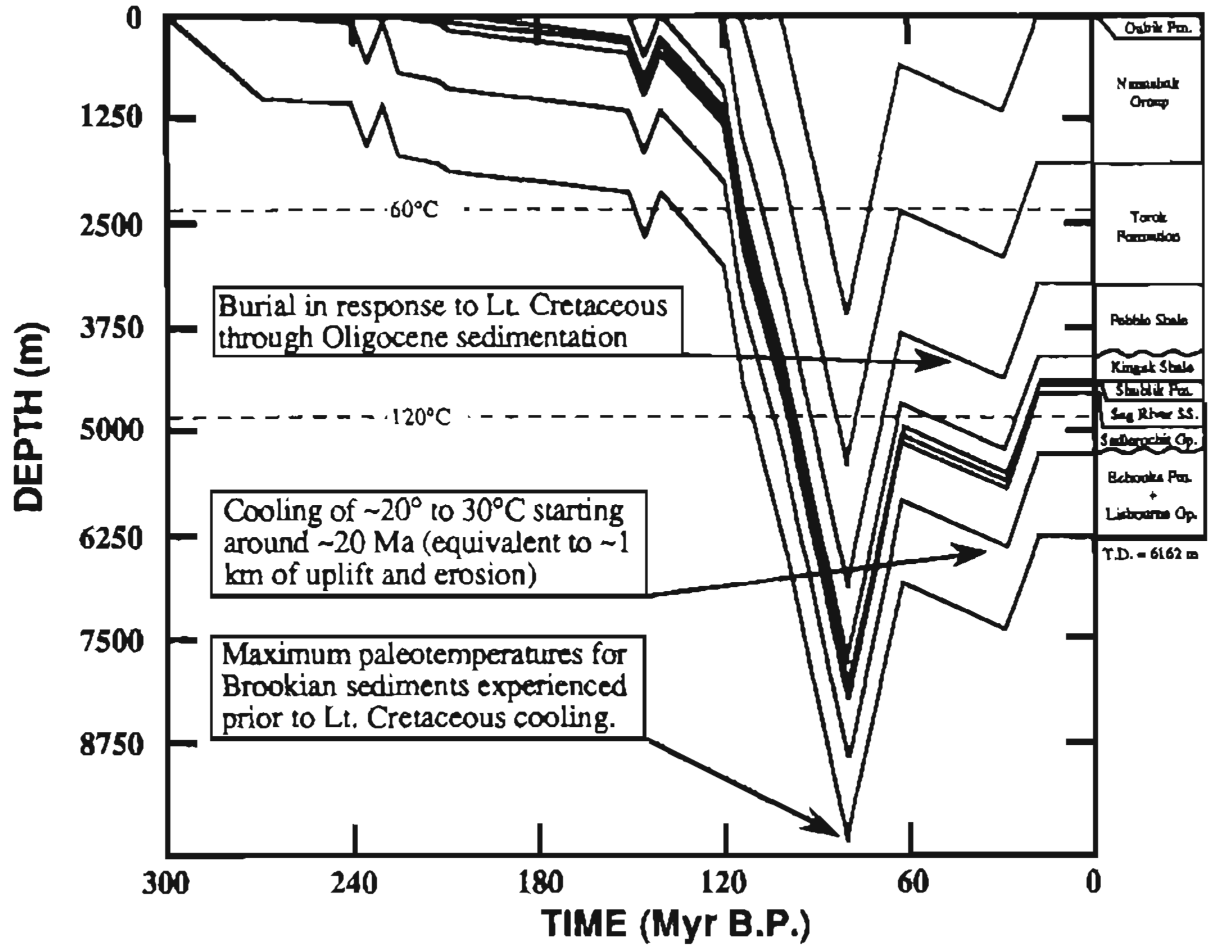


Figure 19: Lopatin diagram showing proposed depositional history for the Husky Tunalik Test Well #1. Based on fission track and vitrinite parameters the well reached maximum paleotemperatures due to burial in the Late Cretaceous. This was followed by two phases of cooling due to uplift/erosion: the first in the Late Cretaceous at ~80-90 Ma; and the second during the Miocene at ~20 Ma.

Husky Walakpa Test Wells #1, #2

The data for the Walakpa Test Wells #1 and #2 include seven samples from the Albian Torok Formation, Neocomian Pebble Shale, Triassic Barrow Sandstone (local name for Sag River Sandstone) and the Franklinian argillite basement. In a composite section for the Walakpa wells (Fig. 20), apatite fission track ages increase from 202 ± 14* Ma in the Torok Formation (~260', 79 m), at estimated present temperatures of less than 5°C, to ~240 ± 40 Ma* ages near the bottom of the well (~3,360', 1,100 m) in the Barrow Sandstone and the Franklinian basement rocks, at

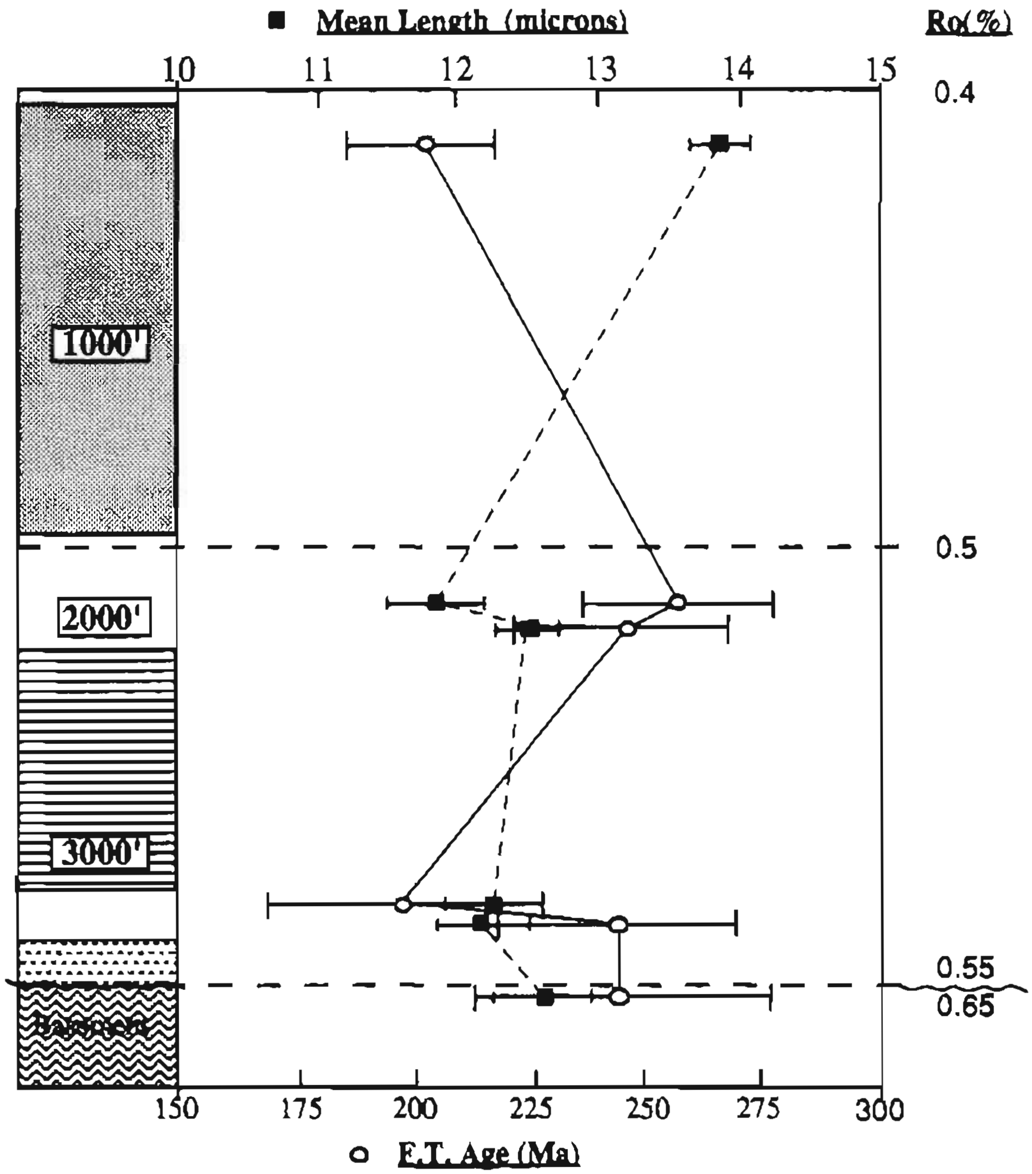


Figure 20: Relationship between depth, apatite fission track age, mean confined track length, and vitrinite reflectance values determined for the Husky Walakpa Test Well #1. Aspects concerning these relationships are discussed in the text.

estimated present temperatures of ~30-34°C. These estimates of present temperature are determined using a geothermal gradient of ~30°C/km for the Walakpa #1 well reported by Blanchard and Tailleur (1982). Over this same section, mean track lengths decrease from 13.8 µm in the Torok Formation to a low of 12.4 µm in the Barrow Sandstone. Two samples, 88 POS 111A and 112A, collected 42' from each other in the Barrow Sandstone were combined for one data point because of poor apatite yields from both.

Unlike the previous two wells, the AFTA data for the Walakpa wells clearly indicate that even the base of the sequence has not been exposed to paleotemperatures greater than ~120°C following deposition. At the base of the well in the Franklinian basement rocks (pre-Mississippian), the vitrinite values are ~0.64% (Bayliss and Magoon, 1988) and the apatite fission track age is ~240 ± 40 Ma*. Based on the vitrinite, the basement rocks have not experienced temperatures greater than ~90-100°C since they cooled in the pre-Mississippian. All fission track ages from the overlying sediments (greater than 200 Ma) are older than, or indistinguishable (within error) from their depositional ages (less than ~220 Ma) and most fail the χ^2 test and are therefore mixed provenance ages.

The general trend of increasing apatite fission track age with depth in this well indicates this section has not been subjected to high temperatures subsequent to deposition. In theory, as erosion progresses in the provenance region, deeper structural levels which have experienced higher temperatures and reduced apatite ages are exposed. In terms of individual grain ages, the similarity between the apatite ages from the basement material and those from the overlying sediments suggest the argillite basement could have initially been a major source terrane for the overlying sediments.

From the apatite data alone, it is difficult to determine the post-depositional paleotemperatures with precision. However, comparing mean track lengths with present temperatures suggests that in the past the samples must have been subjected to higher paleotemperatures. In theory, the presence of short tracks could be either inherited from source regions, or due to the samples having been subjected to sufficient higher paleotemperatures to produce the observed length reduction after deposition. The strong resemblance in individual grain ages between the basement sample and the overlying sediments suggests that the discrepancy between observed values of mean track length to present temperatures can be explained in terms of previously shortened inherited tracks.

This conclusion is not supported by the vitrinite data and preliminary modeling of the basement sample, both of which indicate cooling of approximately ~50-60°C to present temperatures from elevated paleotemperatures. Attempts to model the distribution of confined track lengths for the basement sample suggest two phases of cooling (Fig. 21): the first in the 50-90 Ma range from paleotemperatures of ~90-100°C to ~50-60°C; and the second in the 20-25 Ma range from paleotemperatures of ~60-70°C to ~30°C. Though the initial phase of cooling is poorly constrained, the second cooling phase is well controlled by the shape of the track length distribution. The combined effect of both phases of cooling has resulted in ~1-2 km of uplift/erosion since the Albian.

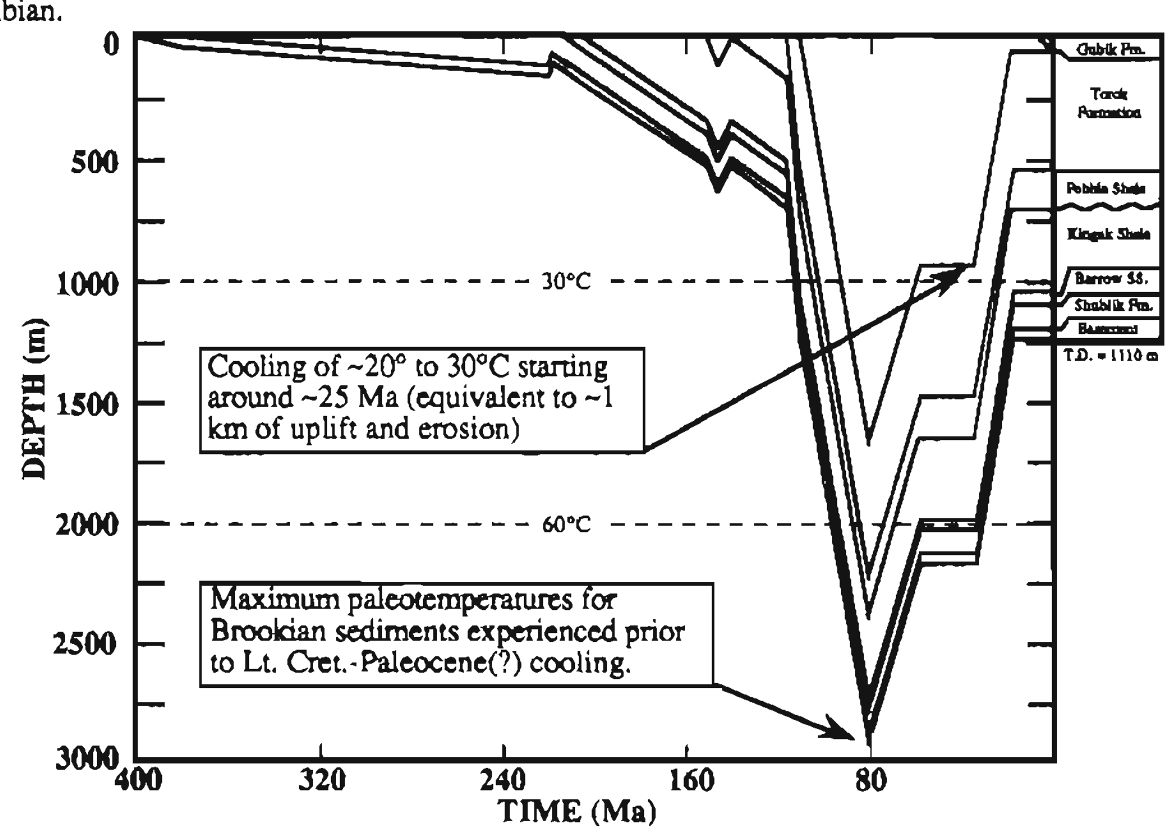


Figure 21: Lopatin diagram showing proposed depositional history for the Husky Walakpa Test Well #1. Based on fission track and vitrinite parameters the well reached maximum paleotemperatures due to burial in the Late Cretaceous. This was followed by two phases of cooling due to uplift/erosion: the first occurred in the Late Cretaceous to Paleocene at ~90-60 Ma; and the second during the Miocene at ~20 Ma.

Exxon Alaska State C-1

The data for the Exxon Alaska State C-1 well include five samples from the early Tertiary Sagavanirktok Formation, Late Cretaceous Canning Formation and the Neocomian Pebble Shale, including the Thomson sand member. In Alaska State C-1, apatite fission track ages decrease from 81.0 ± 24.1 Ma*, at estimated present temperatures of ~20°C in the Sagavanirktok Formation at ~2,200' (667 m), to ~11 Ma ages at estimated present temperatures of ~124°C at the base of the well at ~13,600' (~4,121 m) in the Pebble Shale (Fig. 22; * age given is the mean age due to failure of the χ^2 test). These estimates of present temperature are determined using a geothermal gradient of ~30°C/km reported by Lachenbruch et al. (1987). Downsection, mean track lengths decrease from 12.1 µm in the Sagavanirktok Formation to a low of 8.8 µm in the Pebble Shale. Many of these samples contain tracks much less than ~10 µm indicating exposure to temperatures greater than 60°C but less than ~120°C. One sample, (89 POS 14A), from the base of the well in the Pebble Shale yielded apatite but no confined tracks.

The sample, 89 POS 14A, from the base of the well has a fission track age well above 0 Ma at estimated present temperatures of ~124°C. As mentioned previously, the occurrence of fission tracks at temperatures above ~110°-120°C is unusual and suggests that either the section has reached present temperatures very recently (ie. within the last ~1 Ma) or the present temperature estimate is incorrect. It is believed in this case that the section has recently reached present temperatures given that both the fission track and vitrinite reflectance data are compatible with the section presently residing at maximum paleotemperatures. At the base of the well in the Pebble Shale (Neocomian), the vitrinite values are ~0.56% (Geological Materials Center Data Report #25, 1984) and the apatite fission track age is ~11 Ma. Based on the vitrinite, the Pebble Shale has not experienced temperatures greater than ~80°-90°C since it was deposited. Since the Pebble Shale is now at temperatures slightly higher than that registered by the vitrinite, it suggests that the Pebble Shale is now presiding at maximum paleotemperatures. Even if the present temperature estimate was incorrect, it would only allow for a small change from ~30°C/km to ~28°C/km. Hence a value for the geothermal gradient of ~28-30°C/km is consistent with the fission track data.

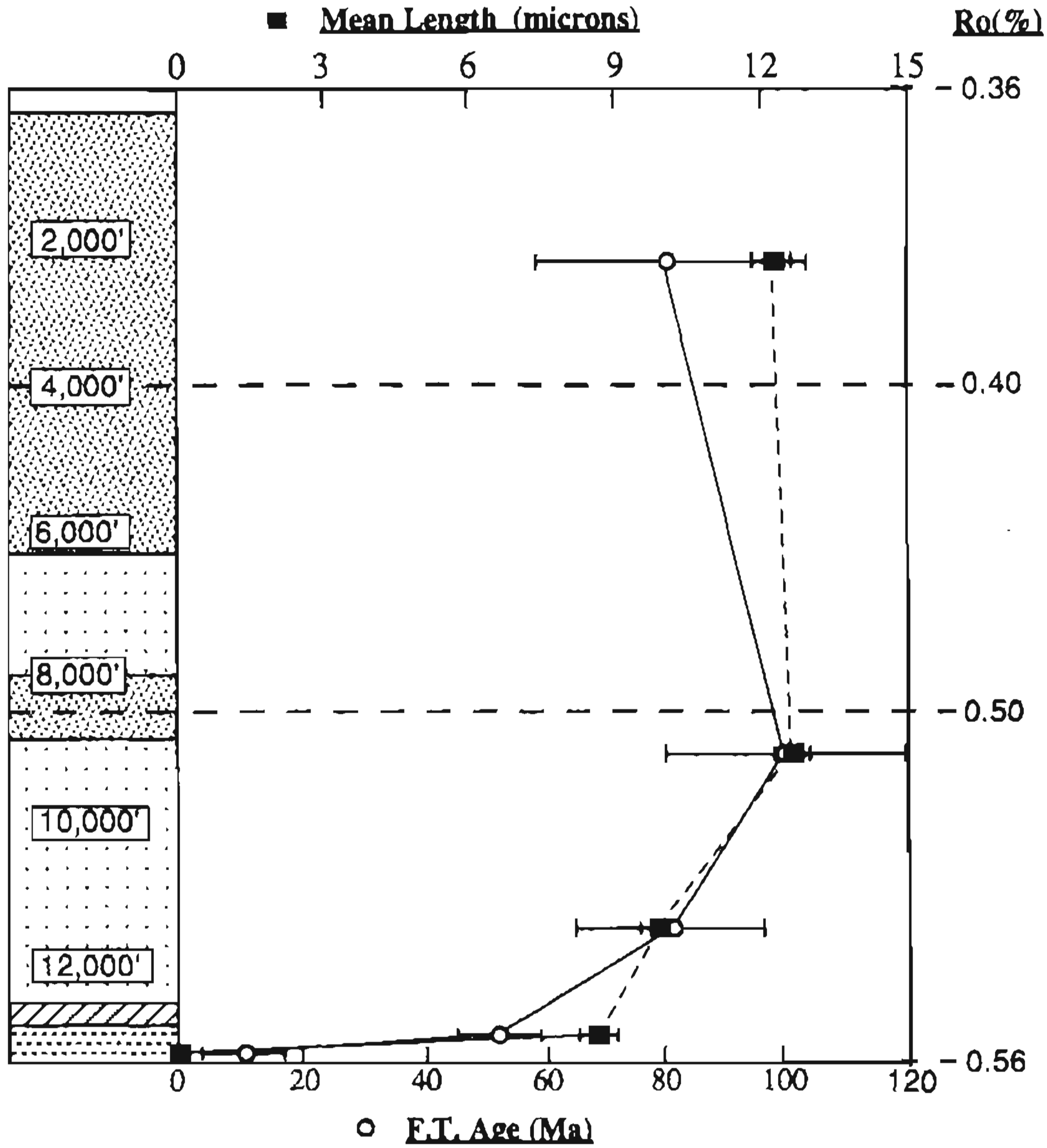


Figure 22: Relationship between depth, apatite fission track age, mean confined track length, and vitrinite reflectance values determined for the Exxon Alaska State C-1 well. Aspects concerning these relationships are discussed in the text.

Like the Walakpa wells, the vitrinite and AFTA data clearly indicate that the base of the section has not been exposed to paleotemperatures greater than ~120°C following deposition. Fission track ages (greater than ~81 Ma*) for the top three samples from the Sagavanirktok and Canning Formations are older than, or indistinguishable (within error) from their depositional ages (less than ~80 Ma). These three samples also fail the χ^2 test and therefore have mixed provenance ages.

Near the bottom of the section, fission track ages for the two samples from the Pebble Shale (less than ~50 Ma) are much younger than their depositional ages (~130 Ma).

Attempts to model the distributions of confined track lengths for the Alaska State C-1 well have proved difficult. From the apatite data alone, it is not possible to determine the post-depositional time-temperature history with precision. Since none of the apatite fission track ages of the samples have been totally reset, it is unclear whether the shortened confined tracks in each sample were affected prior to or after deposition. In theory, the presence of short tracks could be either inherited from source regions, or due to the samples having been subjected to sufficient higher paleotemperatures to produce the observed length reduction after deposition. The strong resemblance of individual grain ages and confined track length distributions between the upper two samples (89 POS 19A, 17A) which are presently sitting at very different temperatures (~80° and ~20°C respectively) suggests that the discrepancy between observed values of mean track length to present temperatures should be explained in terms of previously shortened inherited tracks.

Figure 23 shows the proposed time-temperature path experienced by the Alaska State C-1 well determined by modelling and interpretation of the fission track data. This thermal history is much the same as that determined by Magoon et al. (1987) for the Pt. Thomson Unit-1 well located ~10 km north of the Alaska State C-1 well. Due to the limitations of the fission track data, the only definite interpretation which can be made is that samples in the well are presently at their maximum temperatures. Hence it is not possible to delineate cooling events due to uplift and erosion on the scale of ~1 km. Fission track data from along the Canning River suggest that this might true. Approximately 50 km south of the Alaska State C-1 well, along the Canning River west of the Sadlerochit Mountains, two uplift/erosion events have been determined for the region at ~45 and ~20 Ma (O'Sullivan, 1988; O'Sullivan et al, 1989, and in prep).

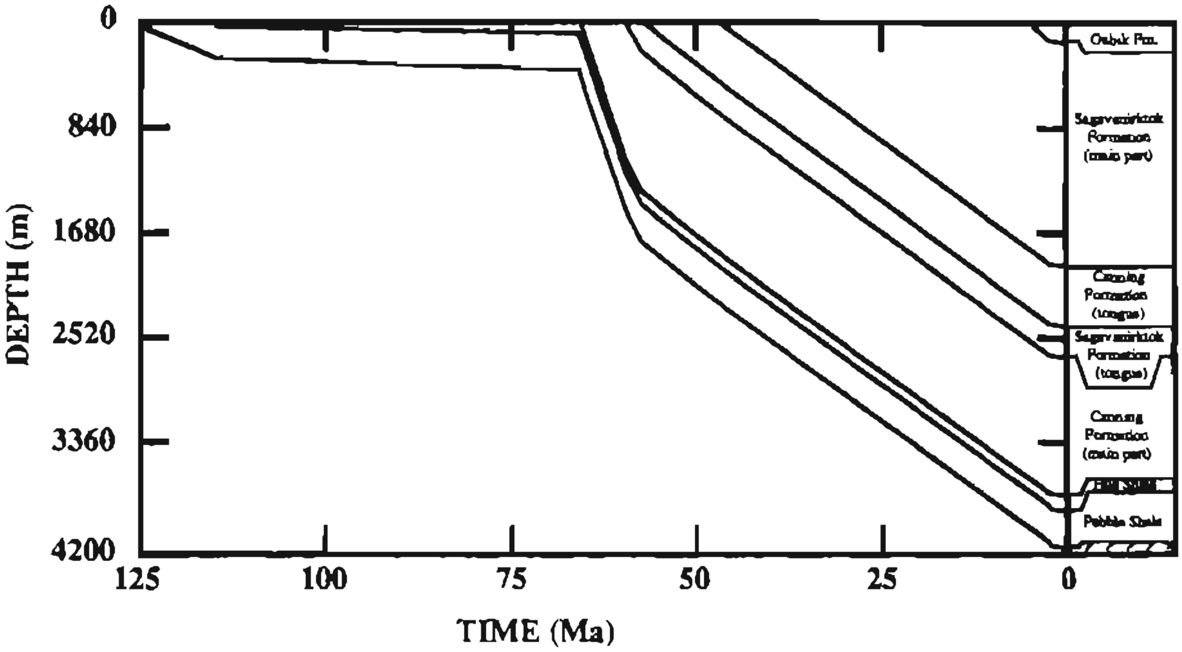


Figure 23: Lopatin diagram showing proposed depositional history for the Exxon Alaska State C-1 well. Based on fission track and vitrinite parameters the well has experienced continual deposition and burial through time to reach present maximum paleotemperatures.

COMPARISON OF FISSION TRACK COOLING AGES AND SUBSURFACE DATA

In a recently completed study by McMillen and O'Sullivan (in press), the record of tectonic uplift due to thrusting in the northeastern Brooks Range is compared to the occurrence of regional unconformities in the subsurface of the coastal plain and offshore. By using seismic reflection and well log data of Paleocene strata from the southern Beaufort Sea margin of Alaska, major regional unconformities and depositional sequences have been identified. A comparison of the age of the unconformities to regional uplift events dated with fission track analysis (O'Sullivan, 1988; O'Sullivan et al., 1989, 1990a, b, and in prep) shows that tectonic events were more important than eustatic changes in controlling the occurrence of regional unconformities (McMillen and O'Sullivan, in press).

Stratigraphic Sequences and Unconformities

Following deposition of Mesozoic and Cenozoic sediments in the foreland basin north of the Brooks Range, mid-Mesozoic thrusting (Mull, 1982; Leiggi, 1987) established the basic structure of the foreland basin. This basin was later filled with sediments and deformed by northward thrusting during the Paleogene (McWhae, 1986; Hubbard et al, 1987).

Several regional Tertiary unconformities have been previously identified in northeastern Alaska and northwestern Canada in the Beaufort/MacKenzie Basin (Dietrich et al, 1985; McNeil, 1989; McMillen and O'Sullivan, in press). Regional unconformities occur in the mid Paleocene, mid Eocene, and latest Eocene from Alaska to Canada (Fig. 24). Additional unconformities occur near the top of the Paleocene and in the late Miocene in Canada, and in the early Miocene in Alaska. The mid Paleocene unconformity is recognized in Alaska by southward tilting and onlap of Paleocene strata (McMillen and O'Sullivan, in press). The latest Paleocene, mid Eocene, early Miocene, and late Miocene unconformities are recognized by erosional truncation of tectonically deformed underlying strata. The latest Eocene unconformity is recognized by minor erosion, a basinward shift in coastal onlap, and extensive submarine fan sedimentation above the unconformity.

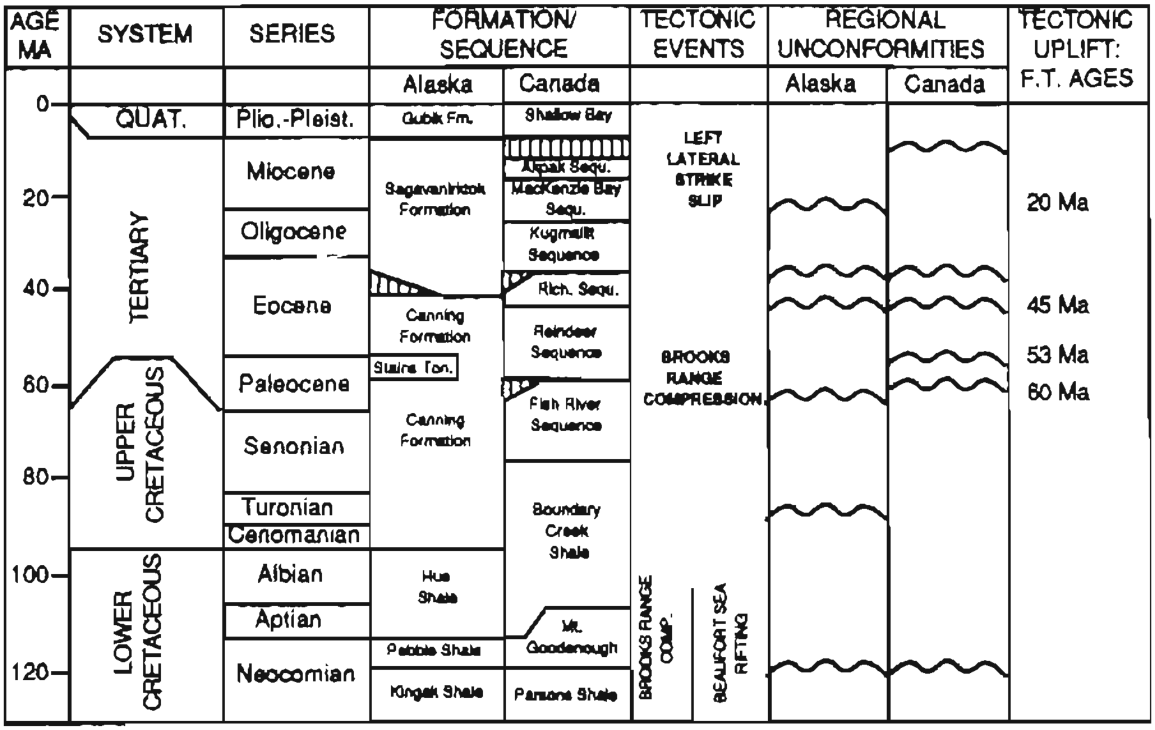


Figure 24: Late Mesozoic and Cenozoic stratigraphy for northeast Alaska and northwest Canada. Sequences (Canada) and Formations (Alaska), tectonic events, major unconformities, and periods of tectonic uplift deduced from apatite fission track analyses are shown (modified after McMillen and O'Sullivan, in press).

Apatite Fission Track Results

Apatite fission track analyses (AFTA) have been used to document rapid cooling events in the Brooks Range of Alaska (O'Sullivan, 1988; O'Sullivan et al., 1989, 1990a, b, and in press) and Canada (O'Sullivan, unpublished data). Rapid cooling can be more easily explained by tectonic uplift/erosion rather than by slower events such as isostatic rebound/erosion or heat flow changes.

Outcrop samples of Permian to Paleogene clastic rocks from five localities in the northeastern Brooks Range of Alaska document the northward younging of uplift/erosion attending the emplacement of thrust sheets (O'Sullivan, 1988; O'Sullivan et al, in prep). AFTA data on the Permian to Albian Bathtub Ridge (Locality 1, Fig. 25) section indicate rapid (less than 3-5 Ma) cooling through 120°-60°C and a minimum of 2 km of uplift/erosion at ~60 Ma (Fig. 26). Combined AFTA data on Early Cretaceous to Paleocene sandstones exposed along the Canning

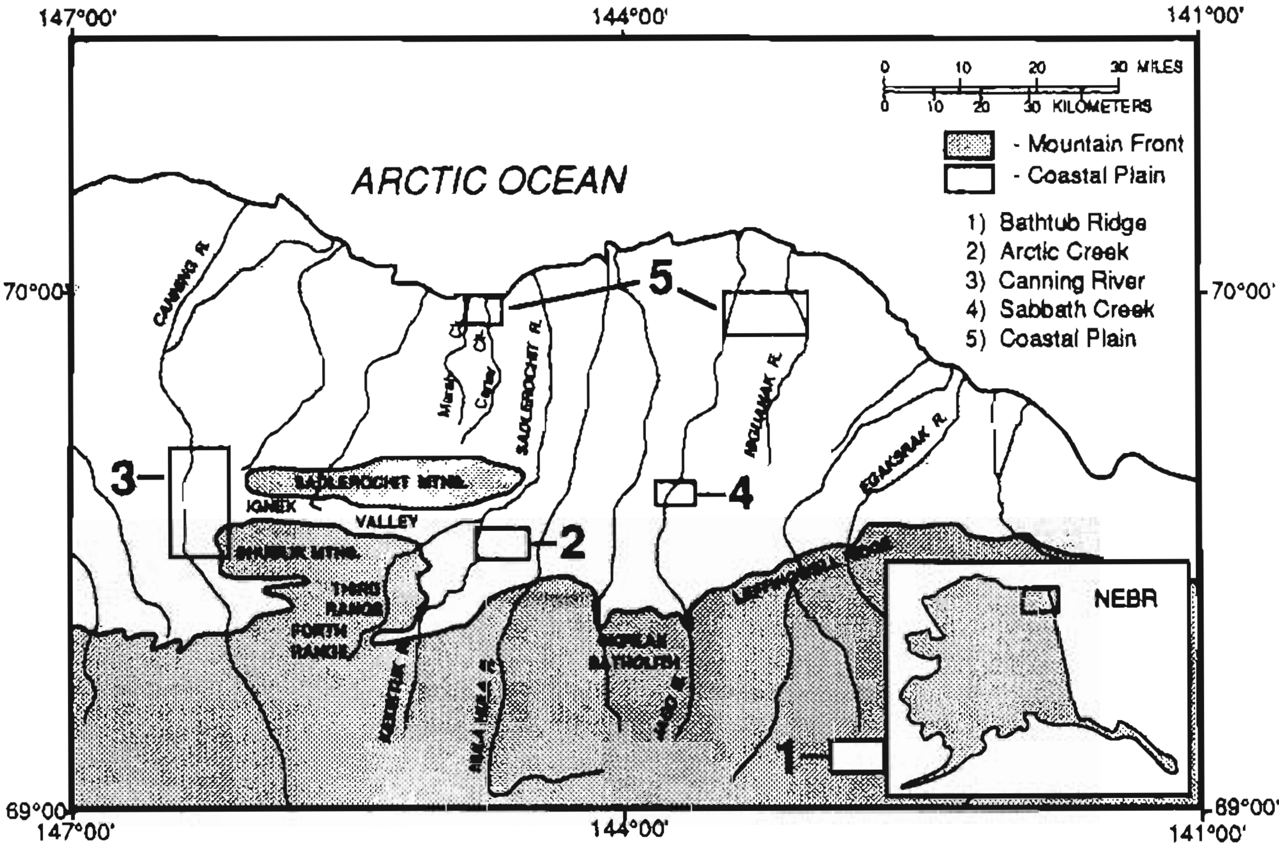


Figure 25: Location map showing areas sampled in the Arctic National Wildlife Refuge. These areas include: Bathtub Ridge, Arctic Creek, Canning River, Sabbath Creek, and the coastal plain (from O'Sullivan et al, in prep).

River west of the Sadlerochit Mountains (Locality 3) and Late Cretaceous to Paleocene sandstones exposed at Sabbath Creek east of the Sadlerochit Mountains (Locality 4) indicate two phases of rapid (less than 3-5 Ma) cooling due to uplift/erosion at ~45 and ~20 Ma (Fig. 26). AFTA data from Albian sedimentary rocks at Arctic Creek (Locality 2) also indicate two phases of cooling and are believed to have experienced the same cooling history as the Canning River and Sabbath Creek sections. AFTA data on Maestrichtian to Eocene sediments from the Arctic Coastal Plain (Locality 5) show that since their deposition these rocks have not been subjected to temperatures greater than ~60°C for longer than ~1 Ma. Unpublished AFTA data on a Late Cretaceous to mid Tertiary section west of the MacKenzie Delta in the Yukon Territory indicate one major phase of cooling during the early Eocene at ~53 Ma. Thus four major regional cooling (uplift/erosion) events are

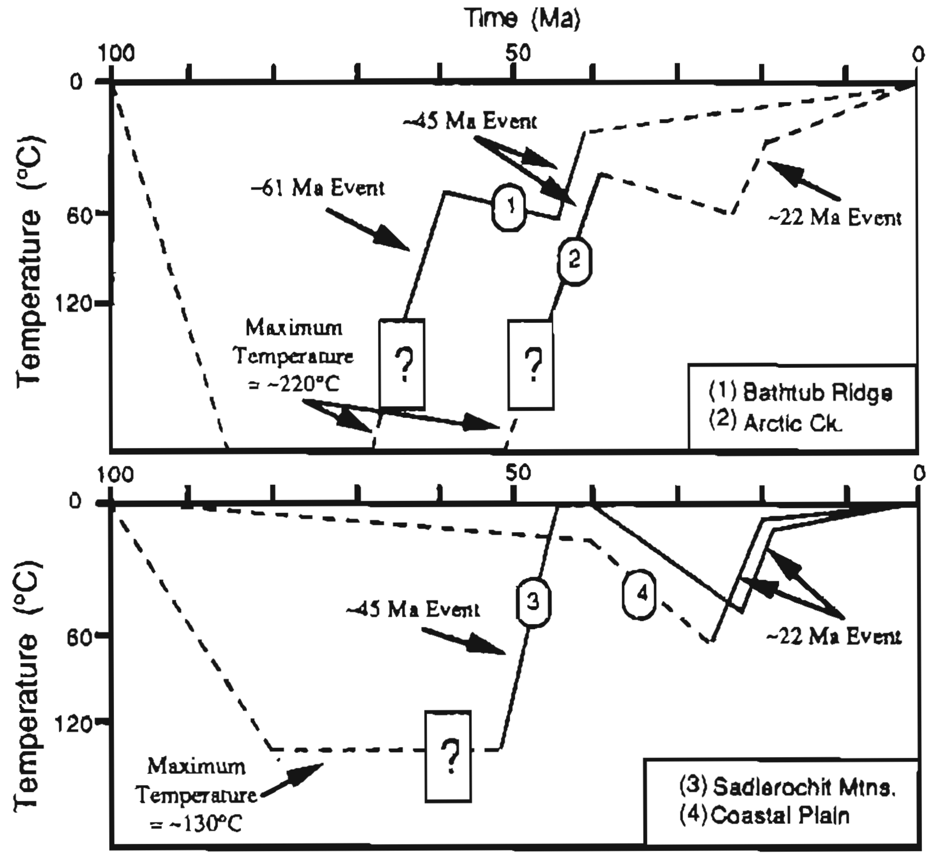


Figure 26: Proposed time vrs. temperature paths for four regions in the northeastern Brooks Range; Bathtub Ridge, Arctic Creek, the Sadlerochit Mountains including the Canning River section and the Sabbath Creek section, and the ANWR coastal plain (from O'Sullivan et al, in prep). This figure is described in the text.

recognized (~60 Ma, 53 Ma, 45 Ma, and 20 Ma) which progressively young to the north. These uplift events are interpreted as separate periods of major duplexing of imbricate thrust sheets (O'Sullivan, 1988; O'Sullivan et al, 1989).

Correlation to Regional Unconformities

Fission track-derived uplift/erosion events determined from the localities described above have been plotted on a time scale next to the subsurface unconformities (Fig. 24). A comparison between uplift/erosion data and subsurface unconformities shows that the mid Paleocene, latest Paleocene, mid Eocene, and early Miocene unconformities correlate to uplift episodes, probably associated with Brooks Range thrusting. The tectonic origin of three of these unconformities is confirmed by the nature of the unconformities themselves. The mid Paleocene unconformity is seen as a northward tilted shelf margin, with tilting probably related to thrust loading in the Brooks Range (McMillen and O'Sullivan, in press). Other Tertiary unconformities do not correlate to thrusting events and may result from lowered eustatic sea level and/or isostatic uplift. These include the late Eocene, and upper Miocene regional unconformities.

CONCLUSIONS

This report presents the results of an apatite fission track analysis (AFTA) study of Mississippian through Tertiary sedimentary rocks from two outcrop areas and five wells on the North Slope of Alaska. Interpretations of fission track ages and confined track length measurements indicate varied histories for the different regions. AFTA data from outcrops in the Umiat-Colville River region indicate the Early Cretaceous sedimentary rocks in the foothills south of Umiat experienced deep burial and temperatures greater than 120°C, followed by a rapid uplift/erosion event at ~57 Ma. Data from Late Cretaceous and Tertiary sediments exposed north of Umiat along the Colville River, show those sediments have not experienced temperatures greater than ~50°C subsequent to deposition. AFTA data from the Sagavanirktok River region indicate that samples collected along two vertical traverses through Marmot Syncline near Slope Mountain, record an uplift/erosion event at ~52 Ma. Further north along the Sagavanirktok River, AFTA data from early Tertiary sediments exposed along Sagwon Bluffs indicate the sediments have not experienced temperatures greater than ~40°C subsequent to deposition.

Modelling of AFTA data from the 5 wells located in NPRA and east of Prudhoe Bay also indicates varied histories for the different regions. Data from the Inigok #1 well indicate two distinct uplift/erosion events resulting in the net removal of ~1-2 km of section. The first occurred during the Paleocene at ~55-60 Ma and the second during the Miocene at ~20-25 Ma. Data from the Tunalik #1 well also indicate two distinct uplift/erosion events resulting in the net removal of ~3-3.5 km of section. The first occurred during the Campanian at ~80-85 Ma and the second during the Miocene at ~20-25 Ma. Data from the two Walakpa wells indicate that samples collected from the base of the well have not experienced temperatures greater than ~90°C subsequent to deposition. Modelling of the data indicates the section has also experienced two uplift/erosion events resulting in the net removal of ~1-2 km. The first of which occurred during the Late Cretaceous/Early Tertiary (?) and the second during the Miocene at ~20-25 Ma. Data from the Exxon Alaska State C-1 are inconclusive except to indicate that the section is presently experiencing its maximum paleotemperature.

Also presented in this report are the results of a comparison between the timing of tectonic uplift events due to thrusting in northeastern Alaska and the seismic record onshore and offshore in the southern Beaufort Sea. The comparison of the age of regional unconformities mapped in the subsurface to the regional uplift events determined by AFTA shows that tectonic events were more important than eustatic changes in controlling the occurrence of regional unconformities mapped offshore.

APPENDIX A - TABLE OF ANALYTICAL RESULTS

Table 1. Fission track analytical results for samples

Sample number	Sample elevation (ft/elev.)	Number of grains	Standard track density ($x10^6$ cm $^{-2}$)	Fossil track density ($x10^6$ cm $^{-2}$)	Induced track density ($x10^6$ cm $^{-2}$)	Chi square probability (%)	Uranium content (ppm)	Age (Ma ± 1 sigma)	Mean track length (um ± 1 sigma)	n (#)	Standard Deviation
UMIAT-COLVILLE RIVER REGION											
88 POS 35A	-	20	2.720 (5975)	0.751 (301)	4.129 (1655)	80.2	19.9	86.7 ± 5.6	13.77 ± 0.12	102	1.24
88 POS 36A	-	20	2.720 (5975)	0.720 (252)	3.642 (1274)	93.7	17.5	92.2 ± 6.7	14.08 ± 0.14	62	1.08
88 POS 37A	-	20	2.720 (5975)	0.802 (289)	4.046 (1458)	42.1	19.5	94.4 ± 6.3	13.98 ± 0.23	22	1.09
88 POS 41A	-	11	2.720 (5975)	0.664 (140)	2.773 (585)	25.3	13.4	113.8 ± 10.9	14.05 ± 0.23	13	0.84
88 POS 44A	-	20	2.720 (5975)	0.881 (350)	3.582 (1423)	4.8	17.3	140.0 ± 16.9*	14.19 ± 0.09	101	0.89
88 POS 48A	-	20	2.760 (6058)	0.518 (281)	3.439 (1865)	2.2	16.3	78.6 ± 9.4*	14.52 ± 0.09	101	0.91
88 POS 51A	-	20	2.427 (5333)	0.104 (104)	5.385 (541)	81.9	2.9	81.8 ± 8.9	13.72 ± 0.20	62	1.54
88 POS 52B	-	20	2.760 (6058)	0.541 (427)	2.905 (2293)	72.6	13.8	90.0 ± 5.0	14.77 ± 0.11	100	1.10
88 POS 53B	-	20	2.760 (6058)	0.566 (181)	2.210 (707)	95.1	10.5	123.4 ± 10.5	13.42 ± 0.25	73	2.09
88 POS 53C	-	20	2.427 (5333)	0.624 (281)	3.036 (1366)	99.5	16.4	87.4 ± 5.9	14.47 ± 0.11	102	1.09
88 POS 55A	-	20	2.427 (5333)	0.210 (221)	0.981 (1032)	95.6	5.3	91.0 ± 6.9	14.86 ± 0.10	101	0.96
88 POS 56A	-	20	2.760 (6058)	0.505 (142)	3.588 (1009)	90.9	17.0	68.1 ± 6.2	13.30 ± 0.68	14	2.54
88 POS 57A	-	20	2.427 (5333)	0.233 (136)	1.711 (997)	100.0	9.2	58.1 ± 5.4	13.88 ± 0.10	100	0.99
88 POS 58A	-	20	2.427 (5333)	0.205 (127)	1.529 (949)	100.0	8.3	57.0 ± 5.5	14.08 ± 0.13	56	0.94
89 KIL 1-C	-	6	1.314 (5630)	0.387 (80)	1.598 (330)	8.8	15.9	55.9 ± 7.0	13.89 ± 0.09	3	0.09
89 KIL 2-B	-	19	1.176 (2791)	0.466 (207)	1.726 (766)	100.0	19.2	55.8 ± 4.5	13.93 ± 0.12	21	1.03
89 KIL 3-B	-	25	1.235 (2791)	0.224 (162)	0.839 (606)	100.0	8.9	58.0 ± 5.3	13.85 ± 0.17	41	1.44
89 KIL 4-B	-	25	1.224 (2791)	0.190 (126)	0.719 (476)	100.0	7.7	56.9 ± 5.8	14.53 ± 0.16	34	1.40
89 KIL 5-B	-	25	1.190 (2971)	0.301 (210)	1.188 (830)	87.5	13.1	52.9 ± 4.2	14.17 ± 0.10	56	0.99
89 KIL 6-C	-	25	1.246 (2791)	0.167 (133)	0.626 (497)	100.0	6.6	58.5 ± 5.9	14.33 ± 0.19	6	0.58

Table 1. Fission track analytical results for samples (continued)

Sample number	Sample depth (ft/elev)	Number of grains	Standard track density (x10^6 cm^{-2})	Fossil track density (x10^6 cm^{-2})	Induced track density (x10^6 cm^{-2})	Chi square probability (%)	Uranium content (ppm)	Age (Ma ± 1 sigma)	Mean track length (um ± 1 sigma)	n (#)	Standard Deviation
SAG RIVER REGION											
(Sagwon Bluffs)											
88 POS 24A	-	25	2.440	0.417	1.499	0.0	8.0	74.1 ± 19.2	14.23 ± 0.13	82	1.16
			(5341)	(322)	(1158)						
88 POS 25A	-	25	2.440	0.327	1.487	0.3	8.0	71.3 ± 14.1	14.17 ± 0.09	102	0.96
			(5341)	(222)	(1010)						
88 POS 26A	-	25	2.440	0.660	2.888	0.0	15.5	72.6 ± 15.1	14.05 ± 0.16	70	1.35
			(5341)	(445)	(1947)						
(Slope Mountain)											
88 POS 22A	-	25	2.440	0.122	1.179	63.7	6.3	44.4 ± 4.3	14.20 ± 0.36	41	2.30
			(5341)	(122)	(1178)						
88 POS 30B	2,340	20	2.323	0.296	2.461	45.5	13.9	49.1 ± 5.2	14.30 ± 0.17	61	1.33
			(5105)	(102)	(848)						
88 POS 31A	2,510	20	2.323	0.161	1.121	82.7	19.1	58.5 ± 8.3	14.17 ± 0.15	102	1.52
			(5105)	(58)	(404)						
88 POS 32A	3,000	20	2.323	0.192	1.381	83.6	7.8	56.6 ± 7.4	13.99 ± 0.30	29	1.63
			(5105)	(67)	(483)						
88 POS 33A	3,640	20	2.323	0.270	2.663	83.1	15.0	41.4 ± 5.0	13.69 ± 0.38	30	2.10
			(5105)	(76)	(749)						
88 POS 34A	4,060	20	2.323	0.287	2.507	87.2	14.1	46.8 ± 4.9	13.68 ± 0.25	51	1.79
			(5105)	(103)	(899)						
(Kongakut Section)											
89 POS 96A	4,260	20	1.334	0.237	1.013	40.2	9.9	54.9 ± 5.0	14.14 ± 0.17	101	1.71
			(2098)	(161)	(687)						
89 POS 97A	3,500	20	1.334	0.200	0.993	79.4	9.8	47.1 ± 4.5	13.71 ± 0.18	100	1.84
			(2098)	(141)	(701)						
89 POS 98A	3,000	20	1.334	0.574	1.578	0.0	15.5	68.7 ± 12.3*	13.14 ± 0.47	12	1.62
			(2098)	(181)	(498)						
89 POS 99A	2,100	20	1.334	0.441	2.306	10.4	22.6	44.8 ± 3.0	13.73 ± 0.25	81	2.25
			(2098)	(304)	(1589)						

Table 1. Fission track analytical results for samples (continued)

Sample number	Sample depth (ft/elev.)	Number of grains	Standard track density ($x10^6$ cm $^{-2}$)	Fossil track density ($x10^6$ cm $^{-2}$)	Induced track density ($x10^6$ cm $^{-2}$)	Chi square probability (%)	Uranium content (ppm)	Age (Ma ± 1 sigma)	Mean track length (um ± 1 sigma)	n (#)	Standard Deviation
N. SLOPE WELLS											
(Tunalik #1)											
88 POS 105A	3,294	20	2.588 (11421)	0.510 (171)	2.880 (966)	64.4	15.7	80.3 ± 6.7	13.87 ± 0.12	106	1.22
88 POS 106A	5,558	20	2.616 (11421)	0.215 (55)	1.607 (411)	99.4	8.7	61.4 ± 8.8	13.02 ± 0.16	80	1.45
88 POS 107A	6,506	20	2.653 (11421)	0.376 (103)	2.834 (776)	98.6	15.4	61.8 ± 6.5	11.80 ± 0.19	78	1.72
88 POS 101A	10,932	20	2.507 (11421)	0.079 (13)	1.435 (237)	91.9	7.8	24.2 ± 6.9	10.00 ± 0.30	9	0.89
88 POS 108A	11,692	13	2.680 (11421)	0.090 (14)	1.644 (256)	52.3	8.9	25.8 ± 7.1	8.57 ± 0.45	10	1.43
88 POS 99A	14,852	18	2.408 (11421)	0.034 (7)	1.459 (302)	30.3	7.9	9.8 ± 3.8	7.39 ± 0.55	20	2.46
88 POS 102A	15,418	13	2.534 (11421)	0.042 (4)	2.244 (215)	59.1	12.2	8.3 ± 4.2	10.04 ± 1.29	5	2.88
88 POS 100A	16,946	15	2.480 (11421)	0.023 (4)	1.810 (316)	19.0	9.8	5.5 ± 2.8	-	0	-
(Walapka #1, #2)											
88 POS 109A	262	41	2.625 (5956)	0.879 (1251)	2.018 (2871)	0.0	10.1	202.4 ± 14.1*	13.82 ± 0.13	99	1.32
88 POS 113A	2,087	20	2.625 (5855)	1.125 (333)	1.982 (587)	80.1	9.9	257.4 ± 18.3	11.90 ± 0.30	26	1.51
88 POS 110A	2,632	20	2.625 (5956)	1.500 (636)	2.715 (1151)	0.0	13.6	245.5 ± 26.6*	12.55 ± 0.19	53	1.42
88 POS 114A	3,100	10	2.625 (5855)	1.080 (211)	2.386 (466)	0.0	11.9	198.4 ± 31.2*	12.24 ± 0.38	15	1.49
88 POS 115A	3,659	9	2.625 (5855)	0.744 (75)	2.014 (203)	2.8	10.0	240.7 ± 40.4*	12.61 ± 0.39	17	1.61
88 POS 111A	3,707	22	2.625 (5956)	0.906 (434)	2.193 (1050)	0.0	10.9	239.7 ± 24.8*	12.18 ± 0.36	28	1.90

Table 1. Fission track analytical results for samples (continued)

Sample number	Sample depth (ft/elev.)	Number of grains	Standard track density ($x10^6$ cm $^{-2}$)	Fossil track density ($x10^6$ cm $^{-2}$)	Induced track density ($x10^6$ cm $^{-2}$)	Chi square probability (%)	Uranium content (ppm)	Age (Ma ± 1 sigma)	Mean track length (um ± 1 sigma)	n (#)	Standard Deviation
N. SLOPE WELLS (continued)											
(Inigok #1)											
88 POS 127A	2,632	20	2.861 (11864)	0.335 (128)	1.722 (657)	74.1	8.4	97.6 ± 9.5	13.38 ± 0.17	102	1.73
88 POS 126A	3,078	20	2.829 (11864)	0.220 (102)	1.117 (518)	99.0	5.5	97.5 ± 10.6	13.13 ± 0.16	102	1.63
88 POS 125A	5,006	20	2.797 (11864)	0.221 (130)	1.057 (622)	99.5	5.2	102.3 ± 9.9	12.87 ± 0.22	105	2.24
88 POS 124A	8,237	20	2.789 (11864)	0.200 (71)	2.490 (884)	29.0	12.2	39.4 ± 4.9	12.19 ± 0.17	77	1.52
88 POS 123A	8,849	20	2.733 (11864)	0.112 (42)	1.391 (520)	94.6	6.8	38.8 ± 6.2	11.30 ± 0.21	60	1.63
88 POS 122A	9,435	20	2.701 (11864)	0.449 (81)	4.293 (775)	30.6	21.1	49.6 ± 5.8	10.68 ± 0.45	27	2.33
88 POS 120A	12,501	16	2.637 (11864)	0.039 (7)	1.538 (279)	65.0	7.5	11.7 ± 4.5	-	0	-
88 POS 119A	12,735	20	2.605 (11864)	0.040 (9)	1.391 (313)	89.1	6.8	13.2 ± 4.5	7.56 ± 1.43	6	3.50
88 POS 117A	19,369	6	2.573 (11864)	0.014 (1)	1.930 (142)	87.4	9.5	3.2 ± 3.2	-	0	-
(Alaska State C-1)											
89 POS 19A	2,200	12	1.218 (2741)	0.848 (190)	1.963 (440)	2.4	21.4	81.0 ± 24.1	12.14 ± 0.47	31	2.63
89 POS 17A	9,100	20	1.218 (2741)	0.599 (226)	1.843 (695)	0.0	19.8	100.3 ± 20.4*	12.27 ± 0.43	21	2.93
89 POS 16A	11,450	25	1.218 (2741)	0.266 (138)	0.988 (513)	0.0	10.6	82.6 ± 16.7*	9.93 ± 0.28	41	1.81
89 POS 15A	13,000	26	1.225 (2756)	0.269 (144)	1.085 (580)	27.4	11.6	53.4 ± 5.1	8.79 ± 0.27	26	2.64
89 POS 14A	13,600	14	1.225 (2756)	0.047 (5)	0.896 (96)	87.4	9.6	11.2 ± 5.2	-	0	-

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.

Ages calculated using ζ=352.7 for dosimeter glass SRM612 (Green, 1985).

* Mean age, used where pooled data fail χ^2 test at 5%.

Results for outcrop areas given in numerical order. Well results given in order of increasing depth below surface.

Data for POS 111A is combined data from POS 111A and POS 112A. These samples are from the same stratigraphic unit and within 42 feet of each other.

APPENDIX B - INDIVIDUAL SAMPLE DATA

This is a preliminary report of apatite fission track analysis data of samples from the Umiat-Colville River region; the Sagavanirktok River region; and from five drill holes; Husky Tunalik Test Well #1, Husky Walakpa Test Wells #1 and #2, Husky Inigok Test Well #1, and Exxon Alaska State C-1; on the North Slope of Alaska. During 1988 and 1989, samples were collected from both outcrop localities and the State of Alaska Geologic Material Center. Apatite grains were separated from the samples and analyzed in Melbourne Australia at the La Trobe University Fission Track Research Laboratory. Separations were completed by the author and Geotrack International. All analyses were completed by the author as part of an ongoing PhD project funded by the U.S. Minerals Management Service Continental Margins Program and the Alaska State geological and Geophysical Survey.

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

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

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

UMIAT-COLVILLE RIVER REGION

Of 37 original samples, these 20 were chosen as representative for the region. Of these 20 samples, 17 yielded adequate apatite for age dating purposes while only 7 contained more than 100 confined tracks.

Sample No.	Formation	Lengths (#)	Mean Length (μm)	Age (Ma)
88 POS 35A	Seabee	102	13.77 ± 0.12	86.7 ± 5.5
88 POS 36A	Seabee	62	14.08 ± 0.14	94.2 ± 6.6
88 POS 37A	Prince Creek	22	13.98 ± 0.23	94.4 ± 6.2
88 POS 41A	Prince Creek	13	14.05 ± 0.23	113.8 ± 10.8
88 POS 44A	Prince Creek	101	14.19 ± 0.09	140.0 ± 16.8
88 POS 48A	Prince Creek	101	14.52 ± 0.09	78.6 ± 9.4
88 POS 51A	Schrader Bluff	62	13.72 ± 0.20	81.8 ± 8.8
88 POS 52B	Seabee	100	14.77 ± 0.11	90.0 ± 4.9
88 POS 53B	Schrader Bluff	73	13.42 ± 0.25	123.4 ± 10.4
88 POS 53C	Schrader Bluff	102	14.47 ± 0.11	87.4 ± 5.9
88 POS 55A	Sagavanirktok	101	14.86 ± 0.10	91.0 ± 6.9
88 POS 56A	Chandler	14	13.30 ± 0.68	68.1 ± 6.2
88 POS 57A	Tuktu	100	13.88 ± 0.10	58.1 ± 5.4
88 POS 58A	Torok	56	14.08 ± 0.13	57.0 ± 5.4
89 KIL 1-C	Tuktu	3	13.89 ± 0.35	55.9 ± 7.0
89 KIL 2-B	Tuktu	21	13.93 ± 0.17	55.8 ± 4.5
89 KIL 3-B	Tuktu	41	13.85 ± 0.21	58.0 ± 5.2
89 KIL 4-B	Tuktu	34	14.53 ± 0.16	56.9 ± 5.8
89 KIL 5-B	Tuktu	56	14.17 ± 0.15	52.9 ± 4.2
89 KIL 6-C	Tuktu	6	14.33 ± 0.31	58.5 ± 4.5

Track Length Data

Sample	Track Length Range (μm)													
Number	<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
35A	0	1	0	0	0	1	3	3	17	24	42	10	1	0
36A	0	0	0	0	0	0	1	0	8	17	27	8	1	0
37A	0	0	0	0	0	0	1	0	3	5	10	3	0	0
41A	0	0	0	0	0	0	0	0	2	5	3	3	0	0
44A	0	0	0	0	0	0	1	0	9	24	50	17	0	0
48A	0	0	0	0	0	0	0	1	4	19	47	26	4	0
51A	0	0	0	0	0	2	2	2	11	16	17	10	1	1
52B	0	0	0	0	0	0	0	1	2	20	35	30	8	4
53B	0	1	0	1	2	1	1	5	16	19	10	10	7	0
53C	0	0	0	0	0	0	0	2	11	15	37	33	4	0
55A	0	0	0	0	0	0	0	0	2	16	37	35	10	1
56A	0	0	1	0	0	0	0	3	2	1	4	2	1	0
57A	0	0	0	0	0	1	0	2	14	34	39	9	1	0
58A	0	0	0	0	0	0	1	1	4	19	24	6	1	0
1-C	0	0	0	0	0	0	0	0	0	1	2	0	0	0
2-B	0	0	0	0	0	0	0	1	3	6	7	4	0	0
3-B	0	0	0	0	0	2	1	0	4	11	17	5	1	0
4-B	0	0	0	0	0	1	1	0	2	4	12	12	2	0
5-B	0	0	0	0	0	0	1	1	4	12	29	9	0	0
6-C	0	0	0	0	0	0	0	0	0	2	3	1	0	0

Individual Age Reports

88 POS 35A - SEABEE FM.

IRRADIATION LU029
SLIDE NUMBER 9
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	9	59	24	0.153	13.5	4.267E+05	2.797E+06	72.8 ± 26.1
2	39	211	16	0.185	72.3	2.773E+06	1.500E+07	88.1 ± 15.4
3	1	9	21	0.111	2.3	5.418E+04	4.876E+05	53.1 ± 56.0
4	15	94	20	0.160	25.8	8.533E+05	5.348E+06	76.1 ± 21.2
5	4	13	20	0.308	3.6	2.276E+05	7.396E+05	145.9 ± 83.5
6	9	70	30	0.129	12.8	3.413E+05	2.655E+06	61.4 ± 21.8
7	15	90	36	0.167	13.7	4.741E+05	2.844E+06	79.5 ± 22.2
8	3	16	25	0.188	3.5	1.365E+05	7.282E+05	89.3 ± 56.2
9	10	53	18	0.189	16.1	6.321E+05	3.350E+06	89.9 ± 31.0
10	22	146	15	0.151	53.3	1.669E+06	1.107E+07	71.9 ± 16.5
11	7	76	24	0.092	17.4	3.319E+05	3.603E+06	44.0 ± 17.4
12	41	228	24	0.180	52.1	1.944E+06	1.081E+07	85.7 ± 14.6
13	24	80	30	0.300	14.6	9.102E+05	3.034E+06	142.3 ± 33.2
14	4	17	28	0.235	3.3	1.625E+05	6.908E+05	111.9 ± 62.2
15	1	6	16	0.167	2.1	7.111E+04	4.267E+05	79.5 ± 85.8
16	19	104	16	0.183	35.6	1.351E+06	7.396E+06	87.0 ± 21.8
17	12	55	25	0.218	12.1	5.461E+05	2.503E+06	103.8 ± 33.1
18	28	120	30	0.233	21.9	1.062E+06	4.551E+06	111.0 ± 23.4
19	36	202	20	0.178	55.3	2.048E+06	1.149E+07	84.9 ± 15.4
20	2	6	18	0.333	1.8	1.264E+05	3.793E+05	157.9 ± 129.0
	301	1655			19.9	7.510E+05	4.129E+06	

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

CHI SQUARED = 13.676 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 80.2 %
CORRELATION COEFFICIENT = 0.963
VARIANCE OF SQR(Ns) = 2.93
VARIANCE OF SQR(Ni) = 16.08

Ns/Ni = 0.182 ± 0.011
MEAN RATIO = 0.193 ± 0.014

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

POOLED AGE = 86.7 ± 5.6 Ma
MEAN AGE = 91.9 ± 6.9 Ma

88 POS 36A - SEABEE FM.

IRRADIATION LU029
SLIDE NUMBER 10
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	6	16	12	0.375	7.3	5.689E+05	1.517E+06	177.4 ± 85.0
2	6	43	15	0.140	15.7	4.551E+05	3.262E+06	66.6 ± 29.0
3	3	26	12	0.115	11.9	2.844E+05	2.465E+06	55.1 ± 33.6
4	8	37	16	0.216	12.7	5.689E+05	2.631E+06	102.9 ± 40.2
5	5	22	18	0.227	6.7	3.161E+05	1.391E+06	108.1 ± 53.6
6	9	50	16	0.180	17.1	6.400E+05	3.556E+06	85.8 ± 31.1
7	11	31	40	0.355	4.2	3.129E+05	8.818E+05	168.0 ± 59.0
8	6	26	18	0.231	7.9	3.793E+05	1.643E+06	109.8 ± 49.7
9	8	42	20	0.190	11.5	4.551E+05	2.389E+06	90.7 ± 35.0
10	46	207	30	0.222	37.8	1.745E+06	7.851E+06	105.7 ± 17.3
11	6	35	15	0.171	12.8	4.551E+05	2.655E+06	81.7 ± 36.1
12	9	69	20	0.130	18.9	5.120E+05	3.925E+06	62.3 ± 22.1
13	13	59	32	0.220	10.1	4.622E+05	2.098E+06	104.8 ± 32.2
14	6	31	12	0.194	14.2	5.689E+05	2.939E+06	92.2 ± 41.1
15	31	167	27	0.186	33.9	1.306E+06	7.037E+06	88.4 ± 17.4
16	35	209	30	0.167	38.2	1.327E+06	7.927E+06	79.8 ± 14.6
17	7	34	20	0.206	9.3	3.982E+05	1.934E+06	98.0 ± 40.7
18	5	26	18	0.192	7.9	3.161E+05	1.643E+06	91.6 ± 44.8
19	29	123	15	0.236	44.9	2.200E+06	9.330E+06	112.1 ± 23.2
20	3	21	12	0.143	9.6	2.844E+05	1.991E+06	68.2 ± 42.1
	252	1274			17.5	7.204E+05	3.642E+06	

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

CHI SQUARED = 10.572 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 93.7 %
CORRELATION COEFFICIENT = 0.971
VARIANCE OF SQR(Ns) = 2.12
VARIANCE OF SQR(Ni) = 10.58

Ns/Ni = 0.198 ± 0.014
MEAN RATIO = 0.205 ± 0.014

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

POOLED AGE = 94.2 ± 6.7 Ma
MEAN AGE = 97.5 ± 7.1 Ma

88 POS 37A - PRINCE CREEK FM.

IRRADIATION LU029
SLIDE NUMBER 11
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	15	47	15	0.319	17.2	1.138E+06	3.565E+06	151.3 ± 44.9
2	23	78	30	0.295	14.2	8.723E+05	2.958E+06	139.9 ± 33.3
3	9	69	25	0.130	15.1	4.096E+05	3.140E+06	62.3 ± 22.1
4	15	95	20	0.158	26.0	8.533E+05	5.404E+06	75.3 ± 21.0
5	10	35	15	0.286	12.8	7.585E+05	2.655E+06	135.6 ± 48.7
6	6	35	18	0.171	10.7	3.793E+05	2.212E+06	81.7 ± 36.1
7	9	49	15	0.184	17.9	6.827E+05	3.717E+06	87.5 ± 31.8
8	9	69	21	0.130	18.0	4.876E+05	3.738E+06	62.3 ± 22.1
9	5	27	15	0.185	9.9	3.793E+05	2.048E+06	88.2 ± 43.0
10	3	21	12	0.143	9.6	2.844E+05	1.991E+06	68.2 ± 42.1
11	30	165	25	0.182	36.2	1.365E+06	7.509E+06	86.6 ± 17.3
12	40	231	40	0.173	31.6	1.138E+06	6.571E+06	82.5 ± 14.2
13	40	130	40	0.308	17.8	1.138E+06	3.698E+06	145.9 ± 26.5
14	18	101	16	0.178	34.6	1.280E+06	7.182E+06	84.9 ± 21.8
15	6	31	12	0.194	14.2	5.689E+05	2.939E+06	92.2 ± 41.1
16	9	50	15	0.180	18.3	6.827E+05	3.793E+06	85.8 ± 31.1
17	26	123	20	0.211	33.7	1.479E+06	6.997E+06	100.6 ± 21.8
18	5	26	18	0.192	7.9	3.161E+05	1.643E+06	91.6 ± 44.8
19	2	6	18	0.333	1.8	1.264E+05	3.793E+05	157.9 ± 129.0
20	9	70	20	0.129	19.2	5.120E+05	3.982E+06	61.4 ± 21.8
	289	1458			19.5	8.020E+05	4.046E+06	

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

CHI SQUARED = 19.573 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 42.1 %
CORRELATION COEFFICIENT = 0.911
VARIANCE OF SQR(Ns) = 2.06
VARIANCE OF SQR(Ni) = 9.54

Ns/Ni = 0.198 ± 0.013
MEAN RATIO = 0.204 ± 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 = 94.4 ± 6.3 Ma
MEAN AGE = 97.2 ± 7.2 Ma

88 POS 41A - PRINCE CREEK FM.

IRRADIATION LU029
SLIDE NUMBER 12
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	5	16	16	0.312	5.5	3.556E+05	1.138E+06	148.2 ± 76.0
2	3	16	20	0.188	4.4	1.707E+05	9.102E+05	89.3 ± 56.2
3	14	50	15	0.280	18.3	1.062E+06	3.793E+06	132.9 ± 40.3
4	18	102	15	0.176	37.3	1.365E+06	7.737E+06	84.1 ± 21.5
5	9	17	20	0.529	4.7	5.120E+05	9.671E+05	249.1 ± 102.8
6	38	127	20	0.299	34.8	2.162E+06	7.225E+06	141.9 ± 26.4
7	9	51	16	0.176	17.5	6.400E+05	3.627E+06	84.1 ± 30.4
8	5	28	20	0.179	7.7	2.844E+05	1.593E+06	85.1 ± 41.3
9	6	35	18	0.171	10.7	3.793E+05	2.212E+06	81.7 ± 36.1
10	24	79	30	0.304	14.4	9.102E+05	2.996E+06	144.1 ± 33.7
11	9	64	50	0.141	7.0	2.048E+05	1.456E+06	67.1 ± 23.9
	140	585			13.4	6.637E+05	2.773E+06	

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

CHI SQUARED = 12.493 WITH 10 DEGREES OF FREEDOM
P(chi squared) = 25.3 %
CORRELATION COEFFICIENT = 0.899
VARIANCE OF SQR(Ns) = 1.75
VARIANCE OF SQR(Ni) = 6.27

Ns/Ni = 0.239 ± 0.023
MEAN RATIO = 0.251 ± 0.034

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

POOLED AGE = 113.8 ± 10.9 Ma
MEAN AGE = 119.1 ± 16.2 Ma

88 POS 44A - PRINCE CREEK FM.

IRRADIATION LU029
SLIDE NUMBER 13
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	4	13	16	0.308	4.5	2.844E+05	9.245E+05	145.9 ± 83.5
2	30	164	20	0.183	44.9	1.707E+06	9.330E+06	87.2 ± 17.4
3	15	51	15	0.294	18.6	1.138E+06	3.868E+06	139.6 ± 41.1
4	9	51	15	0.176	18.6	6.827E+05	3.868E+06	84.1 ± 30.4
5	12	40	18	0.300	12.2	7.585E+05	2.528E+06	142.3 ± 46.9
6	2	6	15	0.333	2.2	1.517E+05	4.551E+05	157.9 ± 129.0
7	18	102	16	0.176	34.9	1.280E+06	7.253E+06	84.1 ± 21.5
8	15	61	20	0.246	16.7	8.533E+05	3.470E+06	116.9 ± 33.7
9	6	35	18	0.171	10.7	3.793E+05	2.212E+06	81.7 ± 36.1
10	24	80	30	0.300	14.6	9.102E+05	3.034E+06	142.3 ± 33.2
11	45	251	50	0.179	27.5	1.024E+06	5.712E+06	85.4 ± 13.9
12	80	265	40	0.302	36.3	2.276E+06	7.538E+06	143.2 ± 18.4
13	7	8	12	0.875	3.7	6.637E+05	7.585E+05	406.6 ± 210.6
14	10	31	20	0.323	8.5	5.689E+05	1.764E+06	152.9 ± 55.7
15	5	28	15	0.179	10.2	3.793E+05	2.124E+06	85.1 ± 41.3
16	20	47	50	0.426	5.2	4.551E+05	1.070E+06	201.0 ± 53.8
17	16	52	20	0.308	14.2	9.102E+05	2.958E+06	145.9 ± 41.8
18	9	65	20	0.138	17.8	5.120E+05	3.698E+06	66.1 ± 23.5
19	20	65	30	0.308	11.9	7.585E+05	2.465E+06	145.9 ± 37.4
20	3	8	12	0.375	3.7	2.844E+05	7.585E+05	177.4 ± 120.1
	350	1423			17.3	8.810E+05	3.582E+06	

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

CHI SQUARED = 30.312 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 4.8 %
CORRELATION COEFFICIENT = 0.928
VARIANCE OF SQR(Ns) = 3.19
VARIANCE OF SQR(Ni) = 14.84

Ns/Ni = 0.246 ± 0.015
MEAN RATIO = 0.295 ± 0.035

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

POOLED AGE = 116.9 ± 7.3 Ma
MEAN AGE = 140.0 ± 16.9 Ma

88 POS 48A - PRINCE CREEK FM.

IRRADIATION LU028
SLIDE NUMBER 1
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	37	343	56	0.108	33.1	7.518E+05	6.969E+06	52.3 ± 9.1
2	2	15	12	0.133	6.8	1.896E+05	1.422E+06	64.6 ± 48.6
3	9	45	30	0.200	8.1	3.413E+05	1.707E+06	96.6 ± 35.3
4	14	56	40	0.250	7.6	3.982E+05	1.593E+06	120.5 ± 36.1
5	16	52	15	0.308	18.7	1.214E+06	3.944E+06	148.0 ± 42.4
6	1	16	16	0.062	5.4	7.111E+04	1.138E+06	30.3 ± 31.3
7	0	9	30	0.000	1.6	0.000E+00	3.413E+05	0.0 ± 0.0
8	21	224	24	0.094	50.4	9.956E+05	1.062E+07	45.5 ± 10.4
9	3	17	24	0.176	3.8	1.422E+05	8.059E+05	85.3 ± 53.5
10	4	27	24	0.148	6.1	1.896E+05	1.280E+06	71.7 ± 38.4
11	24	146	30	0.164	26.3	9.102E+05	5.537E+06	79.5 ± 17.6
12	10	44	24	0.227	9.9	4.741E+05	2.086E+06	109.7 ± 38.5
13	29	199	20	0.146	53.7	1.650E+06	1.132E+07	70.5 ± 14.1
14	14	71	80	0.197	4.8	1.991E+05	1.010E+06	95.3 ± 27.9
15	8	26	14	0.308	10.0	6.502E+05	2.113E+06	148.0 ± 59.9
16	11	60	40	0.183	8.1	3.129E+05	1.707E+06	88.6 ± 29.1
17	33	273	40	0.121	36.9	9.387E+05	7.765E+06	58.6 ± 10.8
18	0	6	12	0.000	2.7	0.000E+00	5.689E+05	0.0 ± 0.0
19	27	167	50	0.162	18.0	6.144E+05	3.800E+06	78.2 ± 16.3
20	18	69	36	0.261	10.4	5.689E+05	2.181E+06	125.7 ± 33.3
	281	1865			16.3	5.182E+05	3.439E+06	

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

CHI SQUARED = 33.349 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 2.2 %
CORRELATION COEFFICIENT = 0.931
VARIANCE OF SQR(Ns) = 3.30
VARIANCE OF SQR(Ni) = 22.66

Ns/Ni = 0.151 ± 0.010
MEAN RATIO = 0.162 ± 0.019

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.760E+06cm-2; ND = 6058

POOLED AGE = 72.9 ± 4.8 Ma
MEAN AGE = 78.6 ± 9.4 Ma

88 POS 51A - SCHRADER BLUFF FM.

IRRADIATION LU019
SLIDE NUMBER 2
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	7	19	50	0.368	2.3	1.593E+05	4.324E+05	155.8 ± 68.9
2	4	11	24	0.364	2.8	1.896E+05	5.215E+05	153.8 ± 89.8
3	4	26	56	0.154	2.9	8.127E+04	5.283E+05	65.5 ± 35.2
4	0	5	42	0.000	0.7	0.000E+00	1.354E+05	0.0 ± 0.0
5	0	3	100	0.000	0.2	0.000E+00	3.413E+04	0.0 ± 0.0
6	8	25	56	0.320	2.7	1.625E+05	5.079E+05	135.5 ± 55.1
7	24	146	64	0.164	14.0	4.267E+05	2.596E+06	70.0 ± 15.5
8	8	38	64	0.211	3.6	1.422E+05	6.756E+05	89.5 ± 34.8
9	0	2	49	0.000	0.2	0.000E+00	4.644E+04	0.0 ± 0.0
10	1	2	70	0.500	0.2	1.625E+04	3.251E+04	210.5 ± 257.9
11	7	43	42	0.163	6.3	1.896E+05	1.165E+06	69.3 ± 28.3
12	5	25	100	0.200	1.5	5.689E+04	2.844E+05	85.0 ± 41.7
13	0	13	60	0.000	1.3	0.000E+00	2.465E+05	0.0 ± 0.0
14	1	5	50	0.200	0.6	2.276E+04	1.138E+05	85.0 ± 93.2
15	6	37	60	0.162	3.8	1.138E+05	7.016E+05	69.0 ± 30.4
16	6	41	50	0.146	5.0	1.365E+05	9.330E+05	62.3 ± 27.3
17	5	15	30	0.333	3.1	1.896E+05	5.689E+05	141.1 ± 72.9
18	8	31	50	0.258	3.8	1.820E+05	7.054E+05	109.5 ± 43.5
19	6	34	70	0.176	3.0	9.752E+04	5.526E+05	75.1 ± 33.3
20	4	20	56	0.200	2.2	8.127E+04	4.064E+05	85.0 ± 46.6
	104	541			2.9	1.035E+05	5.385E+05	

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

CHI SQUARED = 13.374 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 81.9 %
CORRELATION COEFFICIENT = 0.952
VARIANCE OF SQR(Ns) = 1.57
VARIANCE OF SQR(Ni) = 5.98

Ns/Ni = 0.192 ± 0.021
MEAN RATIO = 0.196 ± 0.030

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.427E+06cm-2; ND = 5333

POOLED AGE = 81.8 ± 8.9 Ma
MEAN AGE = 83.3 ± 13.0 Ma

88 POS 52B - SEABEE FM. - SHALE WALL TUFF

IRRADIATION LU028
SLIDE NUMBER 2
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	9	51	20	0.176	13.8	5.120E+05	2.901E+06	85.3 ± 30.9
2	28	155	60	0.181	14.0	5.310E+05	2.939E+06	87.3 ± 18.0
3	26	149	48	0.174	16.8	6.163E+05	3.532E+06	84.4 ± 18.0
4	14	46	25	0.304	9.9	6.372E+05	2.094E+06	146.5 ± 44.8
5	21	152	40	0.138	20.5	5.973E+05	4.324E+06	66.9 ± 15.6
6	11	44	40	0.250	5.9	3.129E+05	1.252E+06	120.5 ± 40.7
7	23	138	60	0.167	12.4	4.362E+05	2.617E+06	80.6 ± 18.2
8	24	125	42	0.192	16.1	6.502E+05	3.386E+06	92.8 ± 20.7
9	40	181	45	0.221	21.7	1.011E+06	4.576E+06	106.7 ± 18.7
10	58	291	90	0.199	17.5	7.332E+05	3.679E+06	96.3 ± 13.9
11	32	161	42	0.199	20.7	8.669E+05	4.362E+06	96.0 ± 18.7
12	20	80	35	0.250	12.3	6.502E+05	2.601E+06	120.5 ± 30.2
13	8	25	24	0.320	5.6	3.793E+05	1.185E+06	153.9 ± 62.6
14	8	48	32	0.167	8.1	2.844E+05	1.707E+06	80.6 ± 30.8
15	22	112	40	0.196	15.1	6.258E+05	3.186E+06	94.9 ± 22.2
16	11	91	50	0.121	9.8	2.503E+05	2.071E+06	58.6 ± 18.7
17	4	45	25	0.089	9.7	1.820E+05	2.048E+06	43.1 ± 22.5
18	17	115	70	0.148	8.9	2.763E+05	1.869E+06	71.6 ± 18.6
19	24	131	60	0.183	11.8	4.551E+05	2.484E+06	88.6 ± 19.7
20	27	153	50	0.176	16.5	6.144E+05	3.482E+06	85.3 ± 17.9
	427	2293			13.8	5.410E+05	2.905E+06	

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

CHI SQUARED = 14.951 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 72.6 %
CORRELATION COEFFICIENT = 0.953
VARIANCE OF SQR(Ns) = 1.78
VARIANCE OF SQR(Ni) = 9.11

Ns/Ni = 0.186 ± 0.010
MEAN RATIO = 0.193 ± 0.013

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.760E+06cm-2; ND = 6058

POOLED AGE = 90.0 ± 5.0 Ma
MEAN AGE = 93.1 ± 6.2 Ma

88 POS 53B - SCHRADER BLUFF FM.

IRRADIATION LU028
SLIDE NUMBER 3
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	2	17	28	0.118	3.3	8.127E+04	6.908E+05	57.0 ± 42.6
2	3	12	12	0.250	5.4	2.844E+05	1.138E+06	120.5 ± 77.8
3	3	9	15	0.333	3.2	2.276E+05	6.827E+05	160.2 ± 106.9
4	5	9	6	0.556	8.1	9.482E+05	1.707E+06	264.9 ± 147.8
5	39	139	21	0.281	35.7	2.113E+06	7.531E+06	135.1 ± 24.6
6	8	22	12	0.364	9.9	7.585E+05	2.086E+06	174.6 ± 72.1
7	2	8	18	0.250	2.4	1.264E+05	5.057E+05	120.5 ± 95.3
8	0	4	14	0.000	1.5	0.000E+00	3.251E+05	0.0 ± 0.0
9	3	16	20	0.188	4.3	1.707E+05	9.102E+05	90.6 ± 57.0
10	61	225	20	0.271	60.8	3.470E+06	1.280E+07	130.6 ± 19.0
11	5	26	15	0.192	9.4	3.793E+05	1.972E+06	92.9 ± 45.4
12	8	38	10	0.211	20.5	9.102E+05	4.324E+06	101.7 ± 39.6
13	4	11	12	0.364	5.0	3.793E+05	1.043E+06	174.6 ± 102.0
14	5	17	15	0.294	6.1	3.793E+05	1.289E+06	141.6 ± 72.1
15	1	8	15	0.125	2.9	7.585E+04	6.068E+05	60.6 ± 64.2
16	5	16	16	0.312	5.4	3.556E+05	1.138E+06	150.3 ± 77.1
17	5	29	40	0.172	3.9	1.422E+05	8.249E+05	83.4 ± 40.4
18	4	9	20	0.444	2.4	2.276E+05	5.120E+05	212.8 ± 127.9
19	13	64	25	0.203	13.8	5.916E+05	2.913E+06	98.1 ± 29.9
20	5	28	30	0.179	5.0	1.896E+05	1.062E+06	86.3 ± 41.9
	181	707			10.5	5.658E+05	2.210E+06	

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

CHI SQUARED = 10.084 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 95.1 %
CORRELATION COEFFICIENT = 0.992
VARIANCE OF SQR(Ns) = 3.01
VARIANCE OF SQR(Ni) = 10.31

Ns/Ni = 0.256 ± 0.021
MEAN RATIO = 0.255 ± 0.028

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.760E+06cm-2; ND = 6058

POOLED AGE = 123.4 ± 10.5 Ma
MEAN AGE = 123.1 ± 13.4 Ma

88 POS 53C - SCHRADER BLUFF FM.

IRRADIATION LU019
SLIDE NUMBER 5
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	8	35	24	0.229	9.0	3.793E+05	1.659E+06	97.1 ± 38.1
2	16	85	45	0.188	11.6	4.045E+05	2.149E+06	80.1 ± 21.9
3	8	42	12	0.190	21.5	7.585E+05	3.982E+06	81.0 ± 31.3
4	9	32	16	0.281	12.3	6.400E+05	2.276E+06	119.3 ± 45.0
5	3	17	20	0.176	5.2	1.707E+05	9.671E+05	75.1 ± 47.0
6	33	212	36	0.156	36.2	1.043E+06	6.700E+06	66.3 ± 12.5
7	24	94	24	0.255	24.1	1.138E+06	4.456E+06	108.4 ± 24.9
8	22	89	40	0.247	13.7	6.258E+05	2.532E+06	104.9 ± 25.1
9	24	117	28	0.205	25.7	9.752E+05	4.754E+06	87.2 ± 19.6
10	5	17	32	0.294	3.3	1.778E+05	6.044E+05	124.7 ± 63.5
11	30	139	15	0.216	56.9	2.276E+06	1.054E+07	91.7 ± 18.5
12	6	25	20	0.240	7.7	3.413E+05	1.422E+06	101.9 ± 46.4
13	7	30	20	0.233	9.2	3.982E+05	1.707E+06	99.1 ± 41.6
14	8	41	15	0.195	16.8	6.068E+05	3.110E+06	83.0 ± 32.1
15	15	90	40	0.167	13.8	4.267E+05	2.560E+06	70.9 ± 19.8
16	11	66	30	0.167	13.5	4.172E+05	2.503E+06	70.9 ± 23.1
17	6	28	20	0.214	8.6	3.413E+05	1.593E+06	91.1 ± 41.0
18	17	78	21	0.218	22.8	9.211E+05	4.226E+06	92.6 ± 24.8
19	23	104	36	0.221	17.7	7.269E+05	3.287E+06	94.0 ± 21.7
20	6	25	18	0.240	8.5	3.793E+05	1.580E+06	101.9 ± 46.4
	281	1366			16.4	6.244E+05	3.036E+06	

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

CHI SQUARED = 6.738 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 99.5 %
CORRELATION COEFFICIENT = 0.955
VARIANCE OF SQR(Ns) = 1.42
VARIANCE OF SQR(Ni) = 8.16

Ns/Ni = 0.206 ± 0.013
MEAN RATIO = 0.217 ± 0.008

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.427E+06cm-2; ND = 5333

POOLED AGE = 87.4 ± 5.9 Ma
MEAN AGE = 92.1 ± 3.9 Ma

88 POS 55A - SAGAVANIRKTOK FM.

IRRADIATION LU019
SLIDE NUMBER 6
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	9	49	60	0.184	5.0	1.707E+05	9.292E+05	78.1 ± 28.4
2	4	20	40	0.200	3.1	1.138E+05	5.689E+05	85.0 ± 46.6
3	2	10	64	0.200	1.0	3.556E+04	1.778E+05	85.0 ± 65.9
4	24	88	81	0.273	6.7	3.371E+05	1.236E+06	115.7 ± 26.7
5	12	60	36	0.200	10.2	3.793E+05	1.896E+06	85.0 ± 26.9
6	4	23	40	0.174	3.5	1.138E+05	6.542E+05	74.0 ± 40.1
7	14	43	100	0.326	2.6	1.593E+05	4.892E+05	137.9 ± 42.5
8	8	49	100	0.163	3.0	9.102E+04	5.575E+05	69.5 ± 26.5
9	11	51	60	0.216	5.2	2.086E+05	9.671E+05	91.7 ± 30.5
10	7	21	80	0.333	1.6	9.956E+04	2.987E+05	141.1 ± 61.6
11	36	216	40	0.167	33.2	1.024E+06	6.144E+06	70.9 ± 12.8
12	4	23	40	0.174	3.5	1.138E+05	6.542E+05	74.0 ± 40.1
13	12	61	36	0.197	10.4	3.793E+05	1.928E+06	83.7 ± 26.5
14	14	45	90	0.311	3.1	1.770E+05	5.689E+05	131.8 ± 40.4
15	11	49	60	0.224	5.0	2.086E+05	9.292E+05	95.4 ± 31.9
16	7	35	30	0.200	7.2	2.655E+05	1.327E+06	85.0 ± 35.2
17	3	15	50	0.200	1.8	6.827E+04	3.413E+05	85.0 ± 53.8
18	13	50	70	0.260	4.4	2.113E+05	8.127E+05	110.3 ± 34.4
19	18	74	60	0.243	7.6	3.413E+05	1.403E+06	103.3 ± 27.2
20	8	50	60	0.160	5.1	1.517E+05	9.482E+05	68.1 ± 26.0
	221	1032			5.3	2.101E+05	9.809E+05	

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

CHI SQUARED = 9.891 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 95.6 %
CORRELATION COEFFICIENT = 0.938
VARIANCE OF SQR(Ns) = 1.22
VARIANCE OF SQR(Ni) = 6.08

Ns/Ni = 0.214 ± 0.016
MEAN RATIO = 0.220 ± 0.012

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.427E+06cm-2; ND = 5333

POOLED AGE = 91.0 ± 6.9 Ma
MEAN AGE = 93.6 ± 5.4 Ma

88 POS 56A - CHANDLER FM.

IRRADIATION LU028
SLIDE NUMBER 4
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	1	8	20	0.125	2.2	5.689E+04	4.551E+05	60.6 ± 64.2
2	7	30	12	0.233	13.5	6.637E+05	2.844E+06	112.6 ± 47.3
3	1	7	14	0.143	2.7	8.127E+04	5.689E+05	69.2 ± 73.9
4	0	3	24	0.000	0.7	0.000E+00	1.422E+05	0.0 ± 0.0
5	11	120	16	0.092	40.5	7.822E+05	8.533E+06	44.5 ± 14.0
6	0	10	16	0.000	3.4	0.000E+00	7.111E+05	0.0 ± 0.0
7	6	37	18	0.162	11.1	3.793E+05	2.339E+06	78.4 ± 34.6
8	11	68	20	0.162	18.4	6.258E+05	3.868E+06	78.3 ± 25.5
9	0	4	15	0.000	1.4	0.000E+00	3.034E+05	0.0 ± 0.0
10	18	113	18	0.159	33.9	1.138E+06	7.143E+06	77.1 ± 19.6
11	1	5	8	0.200	3.4	1.422E+05	7.111E+05	96.6 ± 105.9
12	2	14	18	0.143	4.2	1.264E+05	8.849E+05	69.2 ± 52.3
13	41	267	20	0.154	72.1	2.332E+06	1.519E+07	74.3 ± 12.5
14	17	162	9	0.105	97.2	2.149E+06	2.048E+07	50.9 ± 13.0
15	0	5	12	0.000	2.2	0.000E+00	4.741E+05	0.0 ± 0.0
16	4	16	12	0.250	7.2	3.793E+05	1.517E+06	120.5 ± 67.4
17	0	3	12	0.000	1.4	0.000E+00	2.844E+05	0.0 ± 0.0
18	3	13	9	0.231	7.8	3.793E+05	1.643E+06	111.4 ± 71.3
19	9	69	32	0.130	11.6	3.200E+05	2.453E+06	63.2 ± 22.4
20	10	55	15	0.182	19.8	7.585E+05	4.172E+06	87.9 ± 30.3
	142	1009			17.0	5.049E+05	3.588E+06	

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

CHI SQUARED = 11.428 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 90.9 %
CORRELATION COEFFICIENT = 0.970
VARIANCE OF SQR(Ns) = 3.09
VARIANCE OF SQR(Ni) = 17.63

Ns/Ni = 0.141 ± 0.013
MEAN RATIO = 0.124 ± 0.019

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.760E+06cm-2; ND = 6058

POOLED AGE = 68.1 ± 6.2 Ma
MEAN AGE = 59.8 ± 9.1 Ma

88 POS 57A - TUKTU FM.

IRRADIATION LU019
SLIDE NUMBER 8
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	2	11	18	0.182	3.8	1.264E+05	6.953E+05	77.4 ± 59.5
2	1	10	24	0.100	2.6	4.741E+04	4.741E+05	42.7 ± 44.7
3	4	47	25	0.085	11.5	1.820E+05	2.139E+06	36.3 ± 18.9
4	19	121	30	0.157	24.8	7.206E+05	4.589E+06	66.9 ± 16.5
5	0	2	20	0.000	0.6	0.000E+00	1.138E+05	0.0 ± 0.0
6	2	12	30	0.167	2.5	7.585E+04	4.551E+05	70.9 ± 54.2
7	0	1	16	0.000	0.4	0.000E+00	7.111E+04	0.0 ± 0.0
8	2	12	25	0.167	2.9	9.102E+04	5.461E+05	70.9 ± 54.2
9	6	60	20	0.100	18.4	3.413E+05	3.413E+06	42.7 ± 18.3
10	1	7	12	0.143	3.6	9.482E+04	6.637E+05	60.9 ± 65.1
11	4	21	40	0.190	3.2	1.138E+05	5.973E+05	81.0 ± 44.2
12	25	168	50	0.149	20.6	5.689E+05	3.823E+06	63.4 ± 13.6
13	2	14	50	0.143	1.7	4.551E+04	3.186E+05	60.9 ± 46.0
14	2	13	48	0.154	1.7	4.741E+04	3.082E+05	65.5 ± 49.8
15	8	67	30	0.119	13.7	3.034E+05	2.541E+06	50.9 ± 19.1
16	25	189	90	0.132	12.9	3.161E+05	2.389E+06	56.4 ± 12.0
17	5	28	30	0.179	5.7	1.896E+05	1.062E+06	76.0 ± 36.9
18	8	62	25	0.129	15.2	3.641E+05	2.822E+06	55.0 ± 20.7
19	9	71	30	0.127	14.5	3.413E+05	2.693E+06	54.0 ± 19.1
20	11	81	50	0.136	9.9	2.503E+05	1.843E+06	57.9 ± 18.6
	136	997			9.2	2.334E+05	1.711E+06	

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

CHI SQUARED = 3.564 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 100.0 %
CORRELATION COEFFICIENT = 0.988
VARIANCE OF SQR(Ns) = 2.04
VARIANCE OF SQR(Ni) = 13.64

Ns/Ni = 0.136 ± 0.012
MEAN RATIO = 0.128 ± 0.012

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.427E+06cm-2; ND = 5333

POOLED AGE = 58.1 ± 5.4 Ma
MEAN AGE = 54.5 ± 5.0 Ma

88 POS 58A - TOROK FM.

IRRADIATION LU019
SLIDE NUMBER 9
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	3	20	20	0.150	6.1	1.707E+05	1.138E+06	63.9 ± 39.6
2	12	85	30	0.141	17.4	4.551E+05	3.224E+06	60.1 ± 18.6
3	1	7	25	0.143	1.7	4.551E+04	3.186E+05	60.9 ± 65.1
4	1	7	20	0.143	2.1	5.689E+04	3.982E+05	60.9 ± 65.1
5	4	34	20	0.118	10.4	2.276E+05	1.934E+06	50.2 ± 26.5
6	15	85	48	0.176	10.9	3.556E+05	2.015E+06	75.1 ± 21.1
7	2	14	50	0.143	1.7	4.551E+04	3.186E+05	60.9 ± 46.0
8	17	134	60	0.127	13.7	3.224E+05	2.541E+06	54.1 ± 14.0
9	20	140	80	0.143	10.7	2.844E+05	1.991E+06	60.9 ± 14.6
10	2	15	50	0.133	1.8	4.551E+04	3.413E+05	56.8 ± 42.8
11	3	25	16	0.120	9.6	2.133E+05	1.778E+06	51.2 ± 31.3
12	1	7	12	0.143	3.6	9.482E+04	6.637E+05	60.9 ± 65.1
13	13	102	30	0.127	20.9	4.930E+05	3.868E+06	54.3 ± 16.0
14	6	55	20	0.109	16.9	3.413E+05	3.129E+06	46.5 ± 20.0
15	7	44	20	0.159	13.5	3.982E+05	2.503E+06	67.7 ± 27.6
16	3	15	30	0.200	3.1	1.138E+05	5.689E+05	85.0 ± 53.8
17	14	131	60	0.107	13.4	2.655E+05	2.484E+06	45.6 ± 12.8
18	0	10	25	0.000	2.5	0.000E+00	4.551E+05	0.0 ± 0.0
19	1	7	30	0.143	1.4	3.793E+04	2.655E+05	60.9 ± 65.1
20	2	12	60	0.167	1.2	3.793E+04	2.276E+05	70.9 ± 54.2
	127	949			8.3	2.047E+05	1.529E+06	

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

CHI SQUARED = 4.185 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 100.0 %
CORRELATION COEFFICIENT = 0.977
VARIANCE OF SQR(Ns) = 1.63
VARIANCE OF SQR(Ni) = 11.14

Ns/Ni = 0.134 ± 0.013
MEAN RATIO = 0.135 ± 0.009

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.427E+06cm-2; ND = 5333

POOLED AGE = 57.0 ± 5.5 Ma
MEAN AGE = 57.3 ± 3.8 Ma

89 KIL 1-C - KILLIK TONGUE

IRRADIATION LU051 SLIDE NUMBER 16 COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	27	86	60	0.314	16.3	5.120E+05	1.631E+06	72.3 ± 16.0
2	13	39	56	0.333	7.9	2.641E+05	7.924E+05	76.8 ± 24.6
3	17	68	36	0.250	21.4	5.373E+05	2.149E+06	57.7 ± 15.7
4	3	43	35	0.070	13.9	9.752E+04	1.398E+06	16.1 ± 9.6
5	1	17	24	0.059	8.0	4.741E+04	8.059E+05	13.6 ± 14.0
6	19	77	24	0.247	36.4	9.007E+05	3.650E+06	56.9 ± 14.6
	80	330			15.9	3.873E+05	1.598E+06	

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

CHI SQUARED = 9.571 WITH 5 DEGREES OF FREEDOM
P(chi squared) = 8.8 %
CORRELATION COEFFICIENT = 0.916
VARIANCE OF SQR(Ns) = 2.65
VARIANCE OF SQR(Ni) = 3.73

Ns/Ni = 0.242 ± 0.030
MEAN RATIO = 0.212 ± 0.049

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 1.314E+06cm-2; ND = 5630

POOLED AGE = 55.9 ± 7.0 Ma
MEAN AGE = 49.0 ± 11.3 Ma

89 KIL 2-B - KILLIK TONGUE

IRRADIATION LU052 SLIDE NUMBER 1 COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	3	13	28	0.231	5.9	1.219E+05	5.283E+05	47.7 ± 30.6
2	21	78	40	0.269	24.7	5.973E+05	2.219E+06	55.6 ± 13.7
3	7	34	24	0.206	18.0	3.319E+05	1.612E+06	42.6 ± 17.7
4	3	10	15	0.300	8.4	2.276E+05	7.585E+05	61.9 ± 40.8
5	16	53	42	0.302	16.0	4.334E+05	1.436E+06	62.3 ± 17.8
6	15	61	35	0.246	22.1	4.876E+05	1.983E+06	50.8 ± 14.7
7	10	37	18	0.270	26.1	6.321E+05	2.339E+06	55.8 ± 19.9
8	5	22	15	0.227	18.6	3.793E+05	1.669E+06	47.0 ± 23.3
9	21	71	32	0.296	28.1	7.467E+05	2.524E+06	61.0 ± 15.2
10	47	167	70	0.281	30.2	7.639E+05	2.714E+06	58.1 ± 9.7
11	2	15	24	0.133	7.9	9.482E+04	7.111E+05	27.6 ± 20.8
12	3	9	12	0.333	9.5	2.844E+05	8.533E+05	68.8 ± 45.9
13	9	31	20	0.290	19.6	5.120E+05	1.764E+06	59.9 ± 22.7
14	17	59	30	0.288	24.9	6.447E+05	2.238E+06	59.5 ± 16.4
15	3	12	12	0.250	12.7	2.844E+05	1.138E+06	51.6 ± 33.4
16	0	3	16	0.000	2.4	0.000E+00	2.133E+05	0.0 ± 0.0
17	2	7	12	0.286	7.4	1.896E+05	6.637E+05	59.0 ± 47.3
18	15	57	28	0.263	25.8	6.095E+05	2.316E+06	54.3 ± 15.8
19	8	27	32	0.296	10.7	2.844E+05	9.600E+05	61.2 ± 24.7
	207	766			19.2	4.664E+05	1.726E+06	

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

CHI SQUARED = 3.090 WITH 18 DEGREES OF FREEDOM
P(chi squared) = 100.0 %
CORRELATION COEFFICIENT = 0.995
VARIANCE OF SQR(Ns) = 2.49
VARIANCE OF SQR(Ni) = 7.59

Ns/Ni = 0.270 ± 0.021
MEAN RATIO = 0.251 ± 0.017

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 1.176E+06cm-2; ND = 2791

POOLED AGE = 55.8 ± 4.5 Ma
MEAN AGE = 51.8 ± 3.7 Ma

89 KIL 3-B - KILLIK TONGUE

IRRADIATION LU052 SLIDE NUMBER 6 COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	1	2	12	0.500	2.0	9.482E+04	1.896E+05	108.0 ± 132.3
2	2	8	21	0.250	4.6	1.084E+05	4.334E+05	54.2 ± 42.9
3	17	59	70	0.288	10.2	2.763E+05	9.590E+05	62.4 ± 17.2
4	12	47	50	0.255	11.3	2.731E+05	1.070E+06	55.4 ± 17.9
5	3	8	28	0.375	3.4	1.219E+05	3.251E+05	81.2 ± 55.0
6	5	23	42	0.217	6.6	1.354E+05	6.231E+05	47.2 ± 23.3
7	1	7	15	0.143	5.6	7.585E+04	5.310E+05	31.0 ± 33.2
8	3	9	8	0.333	13.6	4.267E+05	1.280E+06	72.2 ± 48.2
9	0	3	24	0.000	1.5	0.000E+00	1.422E+05	0.0 ± 0.0
10	15	60	80	0.250	9.1	2.133E+05	8.533E+05	54.2 ± 15.7
11	3	10	30	0.300	4.0	1.138E+05	3.793E+05	65.0 ± 42.8
12	2	7	12	0.286	7.0	1.896E+05	6.637E+05	61.9 ± 49.7
13	26	96	70	0.271	16.6	4.226E+05	1.560E+06	58.7 ± 13.0
14	3	12	18	0.250	8.0	1.896E+05	7.585E+05	54.2 ± 35.0
15	2	9	7	0.222	15.5	3.251E+05	1.463E+06	48.2 ± 37.7
16	4	13	54	0.308	2.9	8.428E+04	2.739E+05	66.7 ± 38.1
17	3	8	12	0.375	8.0	2.844E+05	7.585E+05	81.2 ± 55.0
18	6	22	36	0.273	7.4	1.896E+05	6.953E+05	59.1 ± 27.3
19	5	21	24	0.238	10.6	2.370E+05	9.956E+05	51.6 ± 25.7
20	3	11	15	0.273	8.8	2.276E+05	8.344E+05	59.1 ± 38.5
21	3	10	18	0.300	6.7	1.896E+05	6.321E+05	65.0 ± 42.8
22	13	51	20	0.255	30.8	7.396E+05	2.901E+06	55.3 ± 17.2
23	21	76	90	0.276	10.2	2.655E+05	9.608E+05	59.9 ± 14.8
24	4	15	42	0.267	4.3	1.084E+05	4.064E+05	57.8 ± 32.6
25	5	19	24	0.263	9.6	2.370E+05	9.007E+05	57.1 ± 28.7
	162	606			8.9	2.242E+05	8.388E+05	

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

CHI SQUARED = 2.672 WITH 24 DEGREES OF FREEDOM
P(chi squared) = 100.0 %
CORRELATION COEFFICIENT = 0.996
VARIANCE OF SQR(Ns) = 1.47
VARIANCE OF SQR(Ni) = 5.13

Ns/Ni = 0.267 ± 0.024
MEAN RATIO = 0.271 ± 0.017

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 1.235E+06cm-2; ND = 2791

POOLED AGE = 58.0 ± 5.3 Ma
MEAN AGE = 58.7 ± 4.0 Ma

89 KIL 4-B - KILLIK TONGUE

IRRADIATION LU052 SLIDE NUMBER 5 COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	6	18	0.000	4.1	0.000E+00	3.793E+05	0.0 ± 0.0
2	4	13	24	0.308	6.6	1.896E+05	6.163E+05	66.1 ± 37.8
3	2	9	15	0.222	7.3	1.517E+05	6.827E+05	47.8 ± 37.4
4	5	20	48	0.250	5.1	1.185E+05	4.741E+05	53.7 ± 26.9
5	15	58	54	0.259	13.1	3.161E+05	1.222E+06	55.6 ± 16.1
6	2	8	16	0.250	6.1	1.422E+05	5.689E+05	53.7 ± 42.5
7	4	21	42	0.190	6.1	1.084E+05	5.689E+05	41.0 ± 22.4
8	1	4	25	0.250	1.9	4.551E+04	1.820E+05	53.7 ± 60.1
9	5	15	21	0.333	8.7	2.709E+05	8.127E+05	71.6 ± 37.0
10	8	30	42	0.267	8.7	2.167E+05	8.127E+05	57.3 ± 22.8
11	0	3	8	0.000	4.6	0.000E+00	4.267E+05	0.0 ± 0.0
12	4	15	21	0.267	8.7	2.167E+05	8.127E+05	57.3 ± 32.3
13	0	4	10	0.000	4.9	0.000E+00	4.551E+05	0.0 ± 0.0
14	5	14	42	0.357	4.1	1.354E+05	3.793E+05	76.6 ± 40.0
15	2	8	16	0.250	6.1	1.422E+05	5.689E+05	53.7 ± 42.5
16	31	109	70	0.284	19.0	5.039E+05	1.772E+06	61.1 ± 12.5
17	2	8	24	0.250	4.1	9.482E+04	3.793E+05	53.7 ± 42.5
18	2	8	30	0.250	3.2	7.585E+04	3.034E+05	53.7 ± 42.5
19	7	27	60	0.259	5.5	1.327E+05	5.120E+05	55.7 ± 23.7
20	6	21	28	0.286	9.1	2.438E+05	8.533E+05	61.4 ± 28.4
21	1	3	18	0.333	2.0	6.321E+04	1.896E+05	71.6 ± 82.6
22	11	35	60	0.314	7.1	2.086E+05	6.637E+05	67.5 ± 23.4
23	3	15	15	0.200	12.2	2.276E+05	1.138E+06	43.0 ± 27.2
24	4	16	16	0.250	12.2	2.844E+05	1.138E+06	53.7 ± 30.1
25	2	6	30	0.333	2.4	7.585E+04	2.276E+05	71.6 ± 58.4
	126	476			7.7	1.904E+05	7.192E+05	

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

CHI SQUARED = 5.234 WITH 24 DEGREES OF FREEDOM
P(chi squared) = 100.0 %
CORRELATION COEFFICIENT = 0.993
VARIANCE OF SQR(Ns) = 1.47
VARIANCE OF SQR(Ni) = 3.85

Ns/Ni = 0.265 ± 0.027
MEAN RATIO = 0.239 ± 0.020

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 1.224E+06cm-2; ND = 2791

POOLED AGE = 56.9 ± 5.8 Ma
MEAN AGE = 51.3 ± 4.4 Ma

89 KIL 5-B - KILLIK TONGUE

IRRADIATION LU052 SLIDE NUMBER 2 COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	8	21	60	0.381	4.4	1.517E+05	3.982E+05	79.5 ± 33.1
2	16	61	50	0.262	15.3	3.641E+05	1.388E+06	54.8 ± 15.4
3	4	15	12	0.267	15.7	3.793E+05	1.422E+06	55.7 ± 31.4
4	3	13	20	0.231	8.1	1.707E+05	7.396E+05	48.2 ± 30.9
5	2	17	30	0.118	7.1	7.585E+04	6.447E+05	24.6 ± 18.4
6	0	4	24	0.000	2.1	0.000E+00	1.896E+05	0.0 ± 0.0
7	10	84	50	0.119	21.0	2.276E+05	1.911E+06	24.9 ± 8.4
8	21	89	54	0.236	20.6	4.425E+05	1.875E+06	49.3 ± 12.0
9	2	13	35	0.154	4.7	6.502E+04	4.226E+05	32.2 ± 24.5
10	71	253	70	0.281	45.3	1.154E+06	4.112E+06	58.6 ± 8.0
11	1	2	12	0.500	2.1	9.482E+04	1.896E+05	104.1 ± 127.5
12	2	8	9	0.250	11.1	2.528E+05	1.011E+06	52.3 ± 41.3
13	0	5	20	0.000	3.1	0.000E+00	2.844E+05	0.0 ± 0.0
14	4	10	18	0.400	7.0	2.528E+05	6.321E+05	83.4 ± 49.4
15	1	8	21	0.125	4.8	5.418E+04	4.334E+05	26.2 ± 27.8
16	4	9	56	0.444	2.0	8.127E+04	1.829E+05	92.6 ± 55.7
17	25	99	56	0.253	22.1	5.079E+05	2.011E+06	52.8 ± 11.9
18	7	19	36	0.368	6.6	2.212E+05	6.005E+05	76.9 ± 34.0
19	1	2	6	0.500	4.2	1.896E+05	3.793E+05	104.1 ± 127.5
20	3	17	12	0.176	17.7	2.844E+05	1.612E+06	36.9 ± 23.1
21	7	25	49	0.280	6.4	1.625E+05	5.805E+05	58.5 ± 25.0
22	1	3	12	0.333	3.1	9.482E+04	2.844E+05	69.6 ± 80.4
23	4	11	30	0.364	4.6	1.517E+05	4.172E+05	75.9 ± 44.3
24	11	39	45	0.282	10.9	2.781E+05	9.861E+05	58.9 ± 20.2
25	2	3	8	0.667	4.7	2.844E+05	4.267E+05	138.4 ± 126.4
	210	830			13.1	3.005E+05	1.188E+06	

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

CHI SQUARED = 16.353 WITH 24 DEGREES OF FREEDOM
P(chi squared) = 87.5 %
CORRELATION COEFFICIENT = 0.980
VARIANCE OF SQR(Ns) = 3.20
VARIANCE OF SQR(Ni) = 11.59

Ns/Ni = 0.253 ± 0.020
MEAN RATIO = 0.280 ± 0.031

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 1.190E+06cm-2; ND = 2791

POOLED AGE = 52.9 ± 4.2 Ma
MEAN AGE = 58.4 ± 6.6 Ma

89 KIL 6-C - KILLIK TONGUE

IRRADIATION LU052 SLIDE NUMBER 7 COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	4	10	60	0.400	2.0	7.585E+04	1.896E+05	87.3 ± 51.7
2	2	7	12	0.286	7.0	1.896E+05	6.637E+05	62.5 ± 50.1
3	3	9	16	0.333	6.7	2.133E+05	6.400E+05	72.8 ± 48.6
4	16	58	70	0.276	9.9	2.601E+05	9.427E+05	60.3 ± 17.1
5	2	8	6	0.250	15.9	3.793E+05	1.517E+06	54.7 ± 43.3
6	1	3	6	0.333	6.0	1.896E+05	5.689E+05	72.8 ± 84.1
7	7	23	24	0.304	11.5	3.319E+05	1.090E+06	66.5 ± 28.8
8	1	6	45	0.167	1.6	2.528E+04	1.517E+05	36.5 ± 39.5
9	9	28	70	0.321	4.8	1.463E+05	4.551E+05	70.2 ± 27.0
10	21	79	56	0.266	16.9	4.267E+05	1.605E+06	58.1 ± 14.3
11	2	5	54	0.400	1.1	4.214E+04	1.054E+05	87.3 ± 73.1
12	1	3	12	0.333	3.0	9.482E+04	2.844E+05	72.8 ± 84.1
13	2	4	28	0.500	1.7	8.127E+04	1.625E+05	108.9 ± 94.4
14	8	26	40	0.308	7.8	2.276E+05	7.396E+05	67.3 ± 27.2
15	0	4	24	0.000	2.0	0.000E+00	1.896E+05	0.0 ± 0.0
16	7	36	56	0.194	7.7	1.422E+05	7.314E+05	42.6 ± 17.6
17	3	18	36	0.167	6.0	9.482E+04	5.689E+05	36.5 ± 22.8
18	16	67	80	0.239	10.0	2.276E+05	9.529E+05	52.3 ± 14.6
19	3	7	12	0.429	7.0	2.844E+05	6.637E+05	93.5 ± 64.5
20	2	6	16	0.333	4.5	1.422E+05	4.267E+05	72.8 ± 59.5
21	2	7	15	0.286	5.6	1.517E+05	5.310E+05	62.5 ± 50.1
22	7	21	25	0.333	10.0	3.186E+05	9.557E+05	72.8 ± 31.8
23	6	31	72	0.194	5.2	9.482E+04	4.899E+05	42.4 ± 18.9
24	3	12	42	0.250	3.4	8.127E+04	3.251E+05	54.7 ± 35.3
25	5	19	27	0.263	8.4	2.107E+05	8.007E+05	57.6 ± 29.0
	133	497			6.6	1.674E+05	6.255E+05	

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

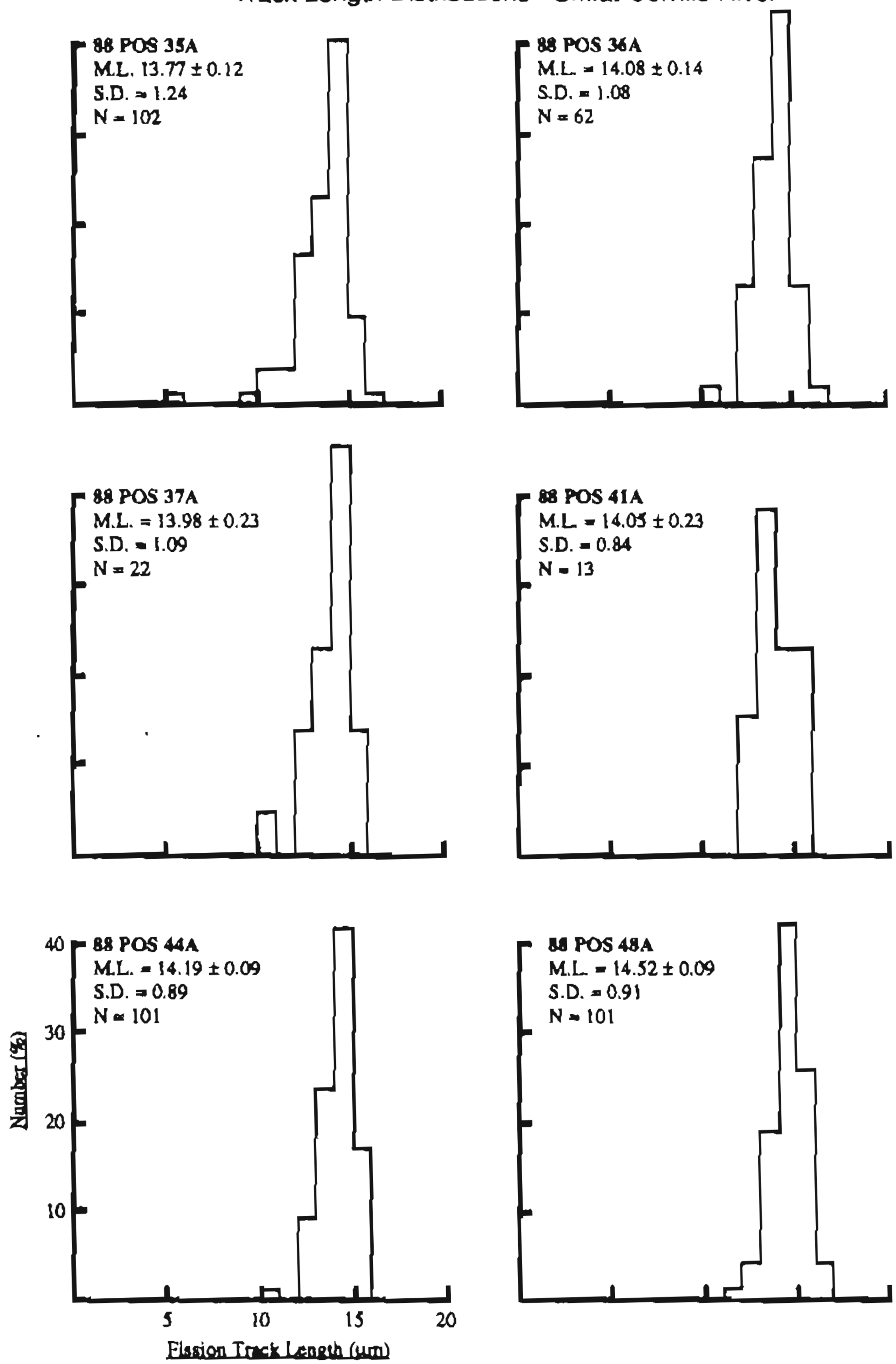
CHI SQUARED = 5.862 WITH 24 DEGREES OF FREEDOM
P(chi squared) = 100.0 %
CORRELATION COEFFICIENT = 0.978
VARIANCE OF SQR(Ns) = 1.13
VARIANCE OF SQR(Ni) = 4.17

Ns/Ni = 0.268 ± 0.026
MEAN RATIO = 0.287 ± 0.020

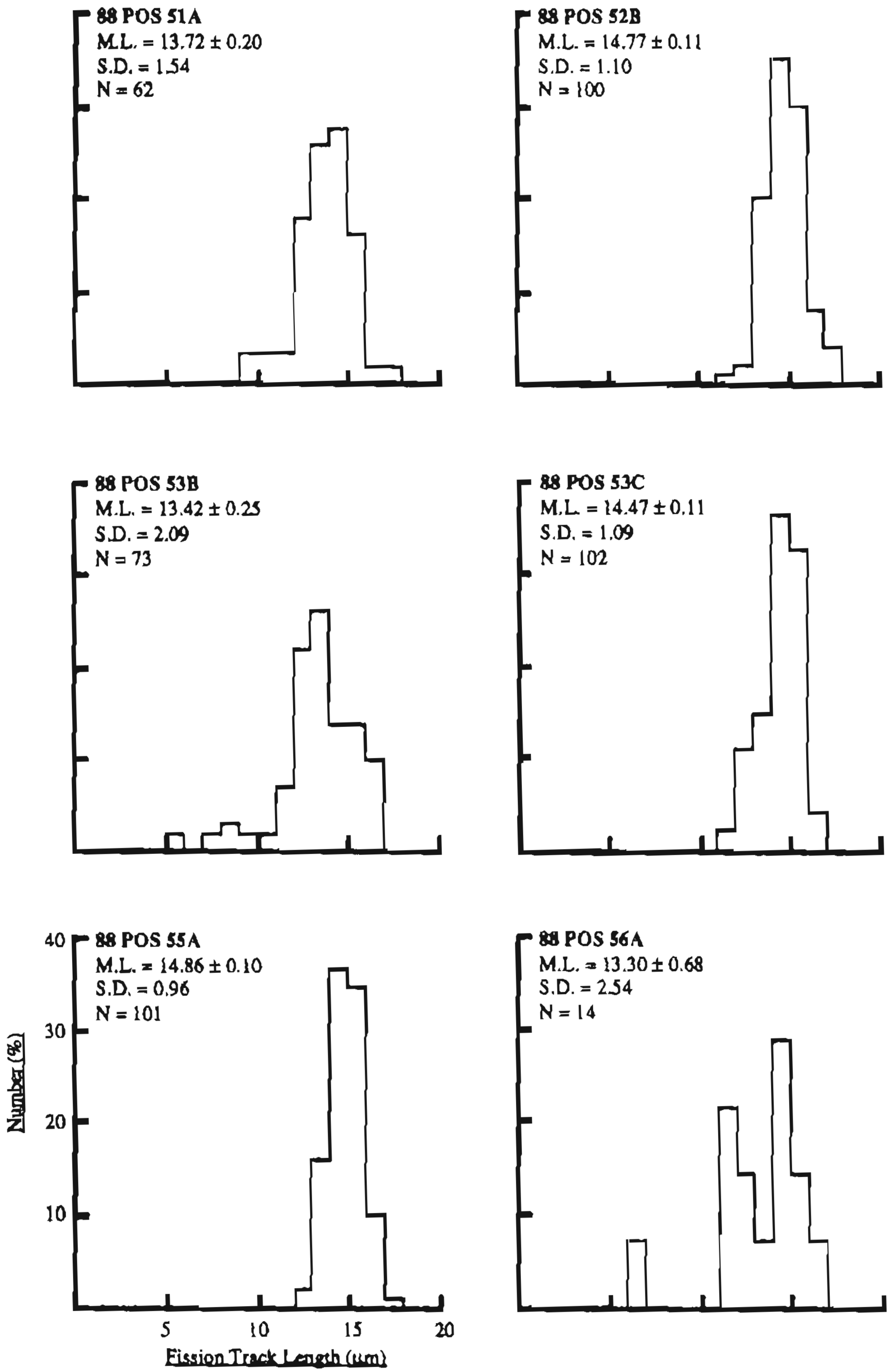
Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 1.246E+06cm-2; ND = 2791

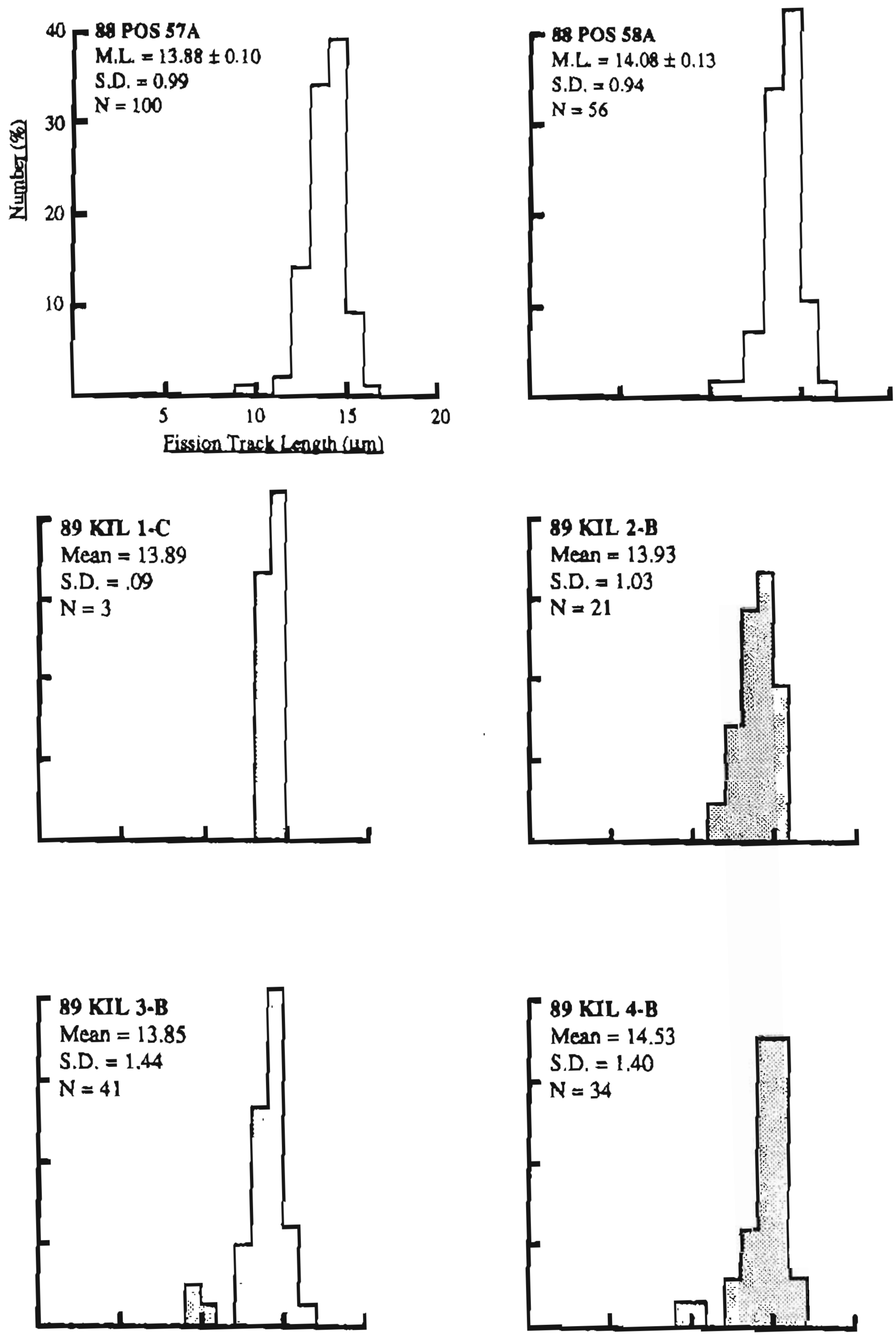
POOLED AGE = 58.5 ± 5.9 Ma
MEAN AGE = 62.7 ± 4.6 Ma

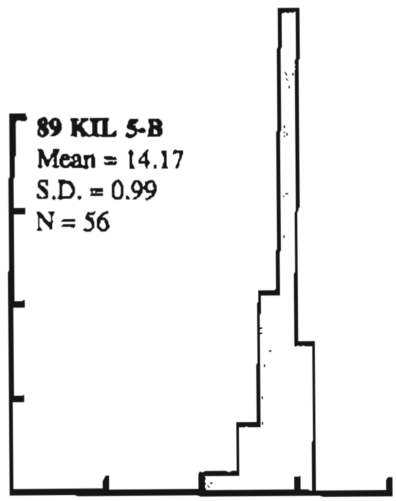
Track Length Distributions - Umiat-Colville River

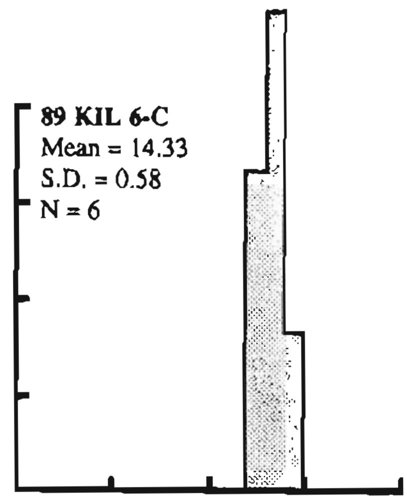


Track Length Distributions


88 POS 51A
M.L. = 13.72 ± 0.20
S.D. = 1.54
N = 62
88 POS 52B
M.L. = 14.77 ± 0.11
S.D. = 1.10
N = 100
88 POS 53B
M.L. = 13.42 ± 0.25
S.D. = 2.09
N = 73
88 POS 53C
M.L. = 14.47 ± 0.11
S.D. = 1.09
N = 102
88 POS 55A
M.L. = 14.86 ± 0.10
S.D. = 0.96
N = 101
88 POS 56A
M.L. = 13.30 ± 0.68
S.D. = 2.54
N = 14
40
30
20
10
Number (%)
5
10
15
20
Fission Track Length (um)


88 POS 57A
M.L. = 13.88 ± 0.10
S.D. = 0.99
N = 100
Number (%)
40
30
20
10
5
10
15
20
Fission Track Length (um)
88 POS 58A
M.L. = 14.08 ± 0.13
S.D. = 0.94
N = 56
89 KIL 1-C
Mean = 13.89
S.D. = .09
N = 3
89 KIL 2-B
Mean = 13.93
S.D. = 1.03
N = 21
89 KIL 3-B
Mean = 13.85
S.D. = 1.44
N = 41
89 KIL 4-B
Mean = 14.53
S.D. = 1.40
N = 34


89 KIL 5-B
Mean = 14.17
S.D. = 0.99
N = 56


89 KIL 6-C
Mean = 14.33
S.D. = 0.58
N = 6

SAVANIRKTOK RIVER REGION

All samples except for one from the Kongakut Section, 89 POS 98A, yielded apatite in adequate amounts for 20 individual grains to be dated. For samples from Slope Mountain, the Kongakut Section, and 89 POS 22A, it was determined that the grains represented a single population and so the pooled age is used for each sample. Samples from further north along the Sagavanirktok River yielded grains representing multiple populations so the mean age is presented (shown by a * in table below). Due to low U-concentrations and young (reset) apatite fission track ages, only 4 samples contained >100 confined tracks. Three other samples from the Tertiary-aged Sagavanirktok Formation located further up-section along the Sagavanirktok River did not contain adequate apatite to analyze and are not listed.

Sample No.	Formation	Elevation (ft)	Lengths (#)	Mean Length (μm)	Age (Ma)
88 POS 22A	Tucktu Fm.	-	41	14.20	44.4
88 POS 24A	Sagwon Mem.	-	82	14.23	74.1*
88 POS 25A	Sagwon Mem.	-	102	14.17	71.3*
88 POS 26A	Sagwon Mem.	-	70	14.05	72.6*
88 POS 30B	Tucktu Fm.	2340	61	14.30	49.1
88 POS 31A	Tucktu Fm.	2510	102	14.17	58.6
88 POS 32A	Tucktu Fm.	3000	29	13.99	56.6
88 POS 33A	Chandlar Fm.	3640	30	13.69	41.4
88 POS 34A	Chandlar Fm.	4060	51	13.68	46.8
89 POS 96A	Fortress Mtn.	4260	101	14.14	54.9
89 POS 97A	Fortress Mtn.	3500	100	13.71	47.1
89 POS 98A	Kongakut Fm.	3000	12	13.14	68.7*
89 POS 99A	Fortress Mtn.	2100	81	13.73	44.9

Track Length Data

Sample	Track Length Range (μm)													
Number	≤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
SAGWON BLUFFS														
22A	1	0	0	0	0	0	1	2	4	7	9	11	6	0
24A	0	0	0	0	0	0	0	3	7	27	27	14	3	1
25A	0	0	0	0	0	0	0	0	15	26	42	16	3	0
26A	0	0	0	0	1	0	0	2	12	18	22	11	3	1
SLOPE MTN.														
30B	0	0	0	1	0	0	1	0	2	16	27	11	3	0
31A	1	0	0	0	0	0	0	2	12	24	38	19	6	0
32A	0	0	0	0	1	0	1	1	1	5	13	7	0	0
33A	0	0	0	1	1	0	0	4	2	6	11	2	3	0
34A	0	0	1	0	1	0	0	5	7	11	15	9	2	0
KONGAKUT														
96A	0	0	1	1	0	1	1	5	8	23	31	21	6	3
97A	1	0	0	0	1	2	3	6	9	29	32	13	3	1
98A	0	0	0	0	0	0	1	2	3	1	4	1	0	0
99A	2	0	0	1	1	0	2	5	9	14	24	16	7	0

Individual Age Reports - Sagwon Bluffs

88 POS 22A - TUCKTU FM.

IRRADIATION GT053
SLIDE NUMBER 1
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	18	112	64	0.161	10.7	3.200E+05	1.991E+06	68.8 ± 17.5
2	0	9	40	0.000	1.4	0.000E+00	2.560E+05	0.0 ± 0.0
3	2	10	36	0.200	1.7	6.321E+04	3.161E+05	85.5 ± 66.2
4	0	13	70	0.000	1.1	0.000E+00	2.113E+05	0.0 ± 0.0
5	0	4	30	0.000	0.8	0.000E+00	1.517E+05	0.0 ± 0.0
6	0	15	20	0.000	4.6	0.000E+00	8.533E+05	0.0 ± 0.0
7	6	67	24	0.090	17.1	2.844E+05	3.176E+06	38.4 ± 16.4
8	0	6	36	0.000	1.0	0.000E+00	1.896E+05	0.0 ± 0.0
9	1	10	70	0.100	0.9	1.625E+04	1.625E+05	42.9 ± 45.0
10	1	8	16	0.125	3.1	7.111E+04	5.689E+05	53.6 ± 56.8
11	0	4	25	0.000	1.0	0.000E+00	1.820E+05	0.0 ± 0.0
12	1	14	24	0.071	3.6	4.741E+04	6.637E+05	30.7 ± 31.7
13	14	166	40	0.084	25.4	3.982E+05	4.722E+06	36.2 ± 10.1
14	9	128	30	0.070	26.1	3.413E+05	4.855E+06	30.2 ± 10.4
15	0	7	36	0.000	1.2	0.000E+00	2.212E+05	0.0 ± 0.0
16	0	26	36	0.000	4.4	0.000E+00	8.217E+05	0.0 ± 0.0
17	0	10	60	0.000	1.0	0.000E+00	1.896E+05	0.0 ± 0.0
18	1	11	30	0.091	2.2	3.793E+04	4.172E+05	39.0 ± 40.7
19	0	12	60	0.000	1.2	0.000E+00	2.276E+05	0.0 ± 0.0
20	1	8	40	0.125	1.2	2.844E+04	2.276E+05	53.6 ± 56.8
21	12	106	50	0.113	13.0	2.731E+05	2.412E+06	48.5 ± 14.8
22	19	117	100	0.162	7.1	2.162E+05	1.331E+06	69.5 ± 17.2
23	5	48	40	0.104	7.3	1.422E+05	1.365E+06	44.7 ± 21.0
24	23	187	100	0.123	11.4	2.617E+05	2.128E+06	52.7 ± 11.7
25	9	80	60	0.112	8.1	1.707E+05	1.517E+06	48.2 ± 17.0
	122	1178			6.3	1.221E+05	1.179E+06	

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

CHI SQUARED = 21.031 WITH 24 DEGREES OF FREEDOM
P(chi squared) = 63.7 %
CORRELATION COEFFICIENT = 0.942
VARIANCE OF SQR(Ns) = 2.71
VARIANCE OF SQR(Ni) = 14.54

Ns/Ni = 0.104 ± 0.010
MEAN RATIO = 0.069 ± 0.013

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.440E+06cm-2; ND = 5341

POOLED AGE = 44.4 ± 4.3 Ma
MEAN AGE = 29.8 ± 5.5 Ma

88 POS 24A - SAGWON MEMBER

IRRADIATION GT053
SLIDE NUMBER 2
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	10	113	36	0.088	19.2	3.161E+05	3.571E+06	38.0 ± 12.5
2	0	3	50	0.000	0.4	0.000E+00	6.827E+04	0.0 ± 0.0
3	1	5	30	0.200	1.0	3.793E+04	1.896E+05	85.5 ± 93.7
4	12	55	12	0.218	28.0	1.138E+06	5.215E+06	93.2 ± 29.7
5	4	30	25	0.133	7.3	1.820E+05	1.365E+06	57.1 ± 30.4
6	0	3	30	0.000	0.6	0.000E+00	1.138E+05	0.0 ± 0.0
7	14	77	25	0.182	18.8	6.372E+05	3.504E+06	77.8 ± 22.6
8	2	28	25	0.071	6.8	9.102E+04	1.274E+06	30.7 ± 22.4
9	12	51	18	0.235	17.3	7.585E+05	3.224E+06	100.5 ± 32.3
10	0	4	27	0.000	0.9	0.000E+00	1.686E+05	0.0 ± 0.0
11	0	5	36	0.000	0.8	0.000E+00	1.580E+05	0.0 ± 0.0
12	1	6	49	0.167	0.7	2.322E+04	1.393E+05	71.3 ± 77.0
13	0	4	40	0.000	0.6	0.000E+00	1.138E+05	0.0 ± 0.0
14	4	28	25	0.143	6.8	1.820E+05	1.274E+06	61.2 ± 32.7
15	0	4	24	0.000	1.0	0.000E+00	1.896E+05	0.0 ± 0.0
16	22	160	40	0.138	24.4	6.258E+05	4.551E+06	58.9 ± 13.4
17	0	3	60	0.000	0.3	0.000E+00	5.689E+04	0.0 ± 0.0
18	15	84	18	0.179	28.5	9.482E+05	5.310E+06	76.4 ± 21.5
19	0	5	24	0.000	1.3	0.000E+00	2.370E+05	0.0 ± 0.0
20	0	4	20	0.000	1.2	0.000E+00	2.276E+05	0.0 ± 0.0
21	25	120	45	0.208	16.3	6.321E+05	3.034E+06	89.0 ± 19.6
22	135	196	100	0.689	12.0	1.536E+06	2.230E+06	289.8 ± 32.8
23	17	19	30	0.895	3.9	6.447E+05	7.206E+05	373.9 ± 125.0
24	36	127	60	0.283	12.9	6.827E+05	2.408E+06	120.8 ± 22.9
25	12	24	30	0.500	4.9	4.551E+05	9.102E+05	211.6 ± 74.9
	322	1158			8.0	4.168E+05	1.499E+06	

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

CHI SQUARED = 135.345 WITH 24 DEGREES OF FREEDOM
P(chi squared) = 0.0 %
CORRELATION COEFFICIENT = 0.770
VARIANCE OF SQR(Ns) = 7.41
VARIANCE OF SQR(Ni) = 15.74

Ns/Ni = 0.278 ± 0.018
MEAN RATIO = 0.173 ± 0.045

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.440E+06cm-2; ND = 5341

POOLED AGE = 118.6 ± 7.8 Ma
MEAN AGE = 74.1 ± 19.2 Ma

88 POS 25A - SAGWON MEMBER

IRRADIATION GT053
SLIDE NUMBER 3
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	3	14	32	0.214	2.7	1.067E+05	4.978E+05	91.6 ± 58.3
2	4	18	28	0.222	3.9	1.625E+05	7.314E+05	94.9 ± 52.5
3	0	7	25	0.000	1.7	0.000E+00	3.186E+05	0.0 ± 0.0
4	32	156	15	0.205	63.5	2.427E+06	1.183E+07	87.7 ± 17.1
5	5	31	12	0.161	15.8	4.741E+05	2.939E+06	69.0 ± 33.3
6	0	6	15	0.000	2.4	0.000E+00	4.551E+05	0.0 ± 0.0
7	3	27	25	0.111	6.6	1.365E+05	1.229E+06	47.6 ± 29.0
8	7	25	42	0.280	3.6	1.896E+05	6.773E+05	119.4 ± 51.1
9	0	5	20	0.000	1.5	0.000E+00	2.844E+05	0.0 ± 0.0
10	3	15	25	0.200	3.7	1.365E+05	6.827E+05	85.5 ± 54.1
11	0	14	30	0.000	2.8	0.000E+00	5.310E+05	0.0 ± 0.0
12	1	7	12	0.143	3.6	9.482E+04	6.637E+05	61.2 ± 65.4
13	5	20	24	0.250	5.1	2.370E+05	9.482E+05	106.7 ± 53.4
14	2	35	60	0.057	3.6	3.793E+04	6.637E+05	24.5 ± 17.8
15	5	51	28	0.098	11.1	2.032E+05	2.072E+06	42.0 ± 19.7
16	0	6	36	0.000	1.0	0.000E+00	1.896E+05	0.0 ± 0.0
17	8	74	12	0.108	37.7	7.585E+05	7.016E+06	46.4 ± 17.3
18	4	29	20	0.138	8.9	2.276E+05	1.650E+06	59.1 ± 31.5
19	0	5	22	0.000	1.4	0.000E+00	2.586E+05	0.0 ± 0.0
20	0	4	20	0.000	1.2	0.000E+00	2.276E+05	0.0 ± 0.0
21	9	31	40	0.290	4.7	2.560E+05	8.818E+05	123.7 ± 46.9
22	17	41	60	0.415	4.2	3.224E+05	7.775E+05	176.0 ± 50.9
23	15	21	40	0.714	3.2	4.267E+05	5.973E+05	300.2 ± 101.6
24	73	281	70	0.260	24.5	1.187E+06	4.567E+06	110.8 ± 14.7
25	26	87	60	0.299	8.9	4.930E+05	1.650E+06	127.3 ± 28.5
	222	1010			8.0	3.268E+05	1.487E+06	

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

CHI SQUARED = 47.145 WITH 24 DEGREES OF FREEDOM
P(chi squared) = 0.3 %
CORRELATION COEFFICIENT = 0.961
VARIANCE OF SQR(Ns) = 4.37
VARIANCE OF SQR(Ni) = 11.85

Ns/Ni = 0.220 ± 0.016
MEAN RATIO = 0.167 ± 0.033

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.440E+06cm-2; ND = 5341

POOLED AGE = 93.9 ± 7.2 Ma
MEAN AGE = 71.3 ± 14.1 Ma

88 POS 26A - SAGWON MEMBER

IRRADIATION GT053
SLIDE NUMBER 4
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	52	311	70	0.167	27.1	8.452E+05	5.055E+06	71.5 ± 10.8
2	10	112	36	0.089	19.0	3.161E+05	3.540E+06	38.3 ± 12.7
3	4	19	30	0.211	3.9	1.517E+05	7.206E+05	90.0 ± 49.5
4	1	5	25	0.200	1.2	4.551E+04	2.276E+05	85.5 ± 93.7
5	33	171	30	0.193	34.8	1.252E+06	6.485E+06	82.5 ± 15.8
6	0	4	30	0.000	0.8	0.000E+00	1.517E+05	0.0 ± 0.0
7	0	6	20	0.000	1.8	0.000E+00	3.413E+05	0.0 ± 0.0
8	3	29	21	0.103	8.4	1.625E+05	1.571E+06	44.4 ± 26.9
9	0	4	28	0.000	0.9	0.000E+00	1.625E+05	0.0 ± 0.0
10	7	26	30	0.269	5.3	2.655E+05	9.861E+05	114.8 ± 48.9
11	15	83	28	0.181	18.1	6.095E+05	3.373E+06	77.3 ± 21.7
12	0	5	12	0.000	2.5	0.000E+00	4.741E+05	0.0 ± 0.0
13	8	79	15	0.101	32.2	6.068E+05	5.992E+06	43.4 ± 16.1
14	4	29	20	0.138	8.9	2.276E+05	1.650E+06	59.1 ± 31.5
15	5	46	30	0.109	9.4	1.896E+05	1.745E+06	46.6 ± 22.0
16	21	156	24	0.135	39.7	9.956E+05	7.396E+06	57.7 ± 13.4
17	0	6	36	0.000	1.0	0.000E+00	1.896E+05	0.0 ± 0.0
18	1	7	12	0.143	3.6	9.482E+04	6.637E+05	61.2 ± 65.4
19	3	25	16	0.120	9.5	2.133E+05	1.778E+06	51.4 ± 31.4
20	0	4	12	0.000	2.0	0.000E+00	3.793E+05	0.0 ± 0.0
21	15	18	30	0.833	3.7	5.689E+05	6.827E+05	349.0 ± 122.2
22	45	179	60	0.251	18.2	8.533E+05	3.394E+06	107.3 ± 18.0
23	120	295	72	0.407	25.0	1.896E+06	4.662E+06	172.7 ± 18.9
24	67	221	45	0.303	30.0	1.694E+06	5.588E+06	129.1 ± 18.2
25	31	107	35	0.290	18.7	1.008E+06	3.478E+06	123.5 ± 25.3
	445	1947			15.5	6.601E+05	2.888E+06	

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

CHI SQUARED = 89.160 WITH 24 DEGREES OF FREEDOM
P(chi squared) = 0.0 %
CORRELATION COEFFICIENT = 0.890
VARIANCE OF SQR(Ns) = 8.65
VARIANCE OF SQR(Ni) = 26.03

Ns/Ni = 0.229 ± 0.012
MEAN RATIO = 0.170 ± 0.035

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.440E+06cm-2; ND = 5341

POOLED AGE = 97.6 ± 5.4 Ma
MEAN AGE = 72.6 ± 15.1 Ma

Individual Age Reports - Slope Mountain

88 POS 30B - TUCKTU FM.

IRRADIATION GT055
SLIDE NUMBER 1
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	16	55	15	0.291	23.5	1.214E+06	4.172E+06	118.1 ± 33.6
2	0	3	9	0.000	2.1	0.000E+00	3.793E+05	0.0 ± 0.0
3	0	4	20	0.000	1.3	0.000E+00	2.276E+05	0.0 ± 0.0
4	6	56	20	0.107	18.0	3.413E+05	3.186E+06	43.7 ± 18.8
5	0	1	25	0.000	0.3	0.000E+00	4.551E+04	0.0 ± 0.0
6	4	57	40	0.070	9.1	1.138E+05	1.621E+06	28.7 ± 14.8
7	20	201	20	0.100	64.5	1.138E+06	1.143E+07	40.6 ± 9.6
8	12	111	20	0.108	35.6	6.827E+05	6.315E+06	44.1 ± 13.4
9	0	8	15	0.000	3.4	0.000E+00	6.068E+05	0.0 ± 0.0
10	3	12	10	0.250	7.7	3.413E+05	1.365E+06	101.6 ± 65.6
11	13	125	10	0.104	80.2	1.479E+06	1.422E+07	42.5 ± 12.4
12	2	12	20	0.167	3.8	1.138E+05	6.827E+05	67.9 ± 51.9
13	0	2	18	0.000	0.7	0.000E+00	1.264E+05	0.0 ± 0.0
14	2	20	20	0.100	6.4	1.138E+05	1.138E+06	40.8 ± 30.3
15	5	31	30	0.161	6.6	1.896E+05	1.176E+06	65.7 ± 31.7
16	6	32	25	0.188	8.2	2.731E+05	1.456E+06	76.4 ± 34.0
17	8	75	20	0.107	24.1	4.551E+05	4.267E+06	43.5 ± 16.2
18	5	34	30	0.147	7.3	1.896E+05	1.289E+06	60.0 ± 28.7
19	0	3	10	0.000	1.9	0.000E+00	3.413E+05	0.0 ± 0.0
20	0	6	15	0.000	2.6	0.000E+00	4.551E+05	0.0 ± 0.0
	102	848			13.9	2.961E+05	2.461E+06	

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

CHI SQUARED = 19.029 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 45.5 %
CORRELATION COEFFICIENT = 0.907
VARIANCE OF SQR(Ns) = 2.27
VARIANCE OF SQR(Ni) = 13.59

Ns/Ni = 0.120 ± 0.013
MEAN RATIO = 0.095 ± 0.020

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.323E+06cm-2; ND = 5105

POOLED AGE = 49.1 ± 5.2 Ma
MEAN AGE = 38.8 ± 8.1 Ma

88 POS 31A - TUCKTU FM.

IRRADIATION GT055
SLIDE NUMBER 2
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	8	12	0.000	0.0	0.000E+00	7.585E+05	0.0 ± 0.0
2	5	33	30	0.152	0.0	1.896E+05	1.252E+06	61.8 ± 29.7
3	1	11	12	0.091	0.0	9.482E+04	1.043E+06	37.1 ± 38.8
4	3	16	20	0.188	0.0	1.707E+05	9.102E+05	76.4 ± 48.1
5	2	16	10	0.125	0.0	2.276E+05	1.820E+06	51.0 ± 38.3
6	0	1	30	0.000	0.0	0.000E+00	3.793E+04	0.0 ± 0.0
7	5	65	12	0.077	0.0	4.741E+05	6.163E+06	31.4 ± 14.6
8	4	10	20	0.400	0.0	2.276E+05	5.689E+05	161.8 ± 95.8
9	0	2	10	0.000	0.0	0.000E+00	2.276E+05	0.0 ± 0.0
10	0	2	28	0.000	0.0	0.000E+00	8.127E+04	0.0 ± 0.0
11	3	27	18	0.111	0.0	1.896E+05	1.707E+06	45.4 ± 27.6
12	1	4	15	0.250	0.0	7.585E+04	3.034E+05	101.6 ± 113.6
13	12	58	15	0.207	0.0	9.102E+05	4.399E+06	84.2 ± 26.7
14	0	5	12	0.000	0.0	0.000E+00	4.741E+05	0.0 ± 0.0
15	2	12	15	0.167	0.0	1.517E+05	9.102E+05	67.9 ± 51.9
16	1	3	20	0.333	0.0	5.689E+04	1.707E+05	135.1 ± 156.0
17	0	5	48	0.000	0.0	0.000E+00	1.185E+05	0.0 ± 0.0
18	2	30	25	0.067	0.0	9.102E+04	1.365E+06	27.3 ± 19.9
19	12	63	18	0.190	0.0	7.585E+05	3.982E+06	77.6 ± 24.5
20	5	33	40	0.152	0.0	1.422E+05	9.387E+05	61.8 ± 29.7
	58	404	·		0.0	1.610E+05	1.121E+06	

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

CHI SQUARED = 13.222 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 82.7 %
CORRELATION COEFFICIENT = 0.874
VARIANCE OF SQR(Ns) = 1.23
VARIANCE OF SQR(Ni) = 5.01

Ns/Ni = 0.144 ± 0.020
MEAN RATIO = 0.125 ± 0.026

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.323E+06cm-2; ND = 5105

POOLED AGE = 58.5 ± 8.3 Ma
MEAN AGE = 51.2 ± 10.6 Ma

88 POS 32A - TUCKTU FM.

IRRADIATION GT055
SLIDE NUMBER 3
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	7	69	10	0.101	44.3	7.964E+05	7.851E+06	41.4 ± 16.4
2	0	3	12	0.000	1.6	0.000E+00	2.844E+05	0.0 ± 0.0
3	5	31	30	0.161	6.6	1.896E+05	1.176E+06	65.7 ± 31.7
4	1	11	12	0.091	5.9	9.482E+04	1.043E+06	37.1 ± 38.8
5	7	59	48	0.119	7.9	1.659E+05	1.399E+06	48.4 ± 19.4
6	9	70	30	0.129	15.0	3.413E+05	2.655E+06	52.5 ± 18.6
7	1	14	20	0.071	4.5	5.689E+04	7.964E+05	29.2 ± 30.2
8	1	16	20	0.062	5.1	5.689E+04	9.102E+05	25.6 ± 26.3
9	1	1	10	1.000	0.6	1.138E+05	1.138E+05	397.2 ± 561.7
10	0	6	18	0.000	2.1	0.000E+00	3.793E+05	0.0 ± 0.0
11	3	12	32	0.250	2.4	1.067E+05	4.267E+05	101.6 ± 65.6
12	1	2	15	0.500	0.9	7.585E+04	1.517E+05	201.6 ± 247.0
13	1	10	10	0.100	6.4	1.138E+05	1.138E+06	40.8 ± 42.8
14	0	5	12	0.000	2.7	0.000E+00	4.741E+05	0.0 ± 0.0
15	1	2	25	0.500	0.5	4.551E+04	9.102E+04	201.6 ± 247.0
16	20	107	20	0.187	34.3	1.138E+06	6.087E+06	76.1 ± 18.6
17	2	15	16	0.133	6.0	1.422E+05	1.067E+06	54.4 ± 41.0
18	0	7	18	0.000	2.5	0.000E+00	4.425E+05	0.0 ± 0.0
19	0	1	20	0.000	0.3	0.000E+00	5.689E+04	0.0 ± 0.0
20	7	42	20	0.167	13.5	3.982E+05	2.389E+06	67.9 ± 27.8
	67	483			7.8	1.915E+05	1.381E+06	

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

CHI SQUARED = 13.053 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 83.6 %
CORRELATION COEFFICIENT = 0.953
VARIANCE OF SQR(Ns) = 1.49
VARIANCE OF SQR(Ni) = 7.64

Ns/Ni = 0.139 ± 0.018
MEAN RATIO = 0.179 ± 0.054

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.323E+06cm-2; ND = 5105

POOLED AGE = 56.6 ± 7.4 Ma
MEAN AGE = 72.7 ± 21.9 Ma

88 POS 33A - CHANDLER FM.

IRRADIATION GT055
SLIDE NUMBER 4
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	4	50	10	3.080	32.1	4.551E+05	5.689E+06	32.7 ± 17.0
2	6	58	20	0.103	18.6	3.413E+05	3.300E+06	42.2 ± 18.1
3	1	8	10	0.125	5.1	1.138E+05	9.102E+05	51.0 ± 54.1
4	8	100	21	0.080	30.6	4.334E+05	5.418E+06	32.7 ± 12.0
5	4	21	18	0.190	7.5	2.528E+05	1.327E+06	77.6 ± 42.3
6	0	8	18	0.000	2.9	0.000E+00	5.057E+05	0.0 ± 0.0
7	0	3	21	0.000	0.9	0.000E+00	1.625E+05	0.0 ± 0.0
8	4	12	20	0.333	3.8	2.276E+05	6.827E+05	135.1 ± 78.1
9	4	30	10	0.133	19.2	4.551E+05	3.413E+06	54.4 ± 29.0
10	12	101	10	0.119	64.8	1.365E+06	1.149E+07	48.5 ± 14.8
11	2	19	20	0.105	6.1	1.138E+05	1.081E+06	43.0 ± 32.0
12	1	3	10	0.333	1.9	1.138E+05	3.413E+05	135.1 ± 156.0
13	1	10	15	0.100	4.3	7.585E+04	7.585E+05	40.8 ± 42.8
14	9	109	15	0.083	46.6	6.827E+05	8.268E+06	33.7 ± 11.7
15	5	34	21	0.147	10.4	2.709E+05	1.842E+06	60.0 ± 28.7
16	9	89	15	0.101	38.1	6.827E+05	6.751E+06	41.3 ± 14.5
17	0	17	20	0.000	5.5	0.000E+00	9.671E+05	0.0 ± 0.0
18	0	6	10	0.000	3.8	0.000E+00	6.827E+05	0.0 ± 0.0
19	1	12	15	0.083	5.1	7.585E+04	9.102E+05	34.0 ± 35.4
20	5	59	21	0.085	18.0	2.709E+05	3.197E+06	34.6 ± 16.1
	76	749			15.0	2.702E+05	2.663E+06	

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

CHI SQUARED = 13.142 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 83.1 %
CORRELATION COEFFICIENT = 0.934
VARIANCE OF SQR(Ns) = 1.20
VARIANCE OF SQR(Ni) = 8.54

Ns/Ni = 0.101 ± 0.012
MEAN RATIO = 0.110 ± 0.021

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.323E+06cm-2; ND = 5105

POOLED AGE = 41.4 ± 5.0 Ma
MEAN AGE = 44.9 ± 8.4 Ma

88 POS 34A - CHANDLER FM.

IRRADIATION GT055
SLIDE NUMBER 5
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	8	40	50	0.200	5.1	1.820E+05	9.102E+05	81.4 ± 31.6
2	7	57	18	0.123	20.3	4.425E+05	3.603E+06	50.1 ± 20.1
3	1	8	10	0.125	5.1	1.138E+05	9.102E+05	51.0 ± 54.1
4	0	1	21	0.000	0.3	0.000E+00	5.418E+04	0.0 ± 0.0
5	31	312	20	0.099	100.1	1.764E+06	1.775E+07	40.6 ± 7.7
6	0	8	18	0.000	2.9	0.000E+00	5.057E+05	0.0 ± 0.0
7	0	3	21	0.000	0.9	0.000E+00	1.625E+05	0.0 ± 0.0
8	7	90	25	0.078	23.1	3.186E+05	4.096E+06	31.8 ± 12.5
9	2	16	20	0.125	5.1	1.138E+05	9.102E+05	51.0 ± 38.3
10	1	5	15	0.200	2.1	7.585E+04	3.793E+05	81.4 ± 89.2
11	1	4	20	0.250	1.3	5.689E+04	2.276E+05	101.6 ± 113.6
12	10	117	18	0.085	41.7	6.321E+05	7.396E+06	34.9 ± 11.5
13	12	58	18	0.207	20.7	7.585E+05	3.666E+06	84.2 ± 26.7
14	0	4	8	0.000	3.2	0.000E+00	5.689E+05	0.0 ± 0.0
15	2	13	15	0.154	5.6	1.517E+05	9.861E+05	62.7 ± 47.7
16	2	15	16	0.133	6.0	1.422E+05	1.067E+06	54.4 ± 41.0
17	1	5	15	0.200	2.1	7.585E+04	3.793E+05	81.4 ± 89.2
18	3	24	20	0.125	7.7	1.707E+05	1.365E+06	51.0 ± 31.2
19	15	112	45	0.134	16.0	3.793E+05	2.832E+06	54.6 ± 15.1
20	0	7	15	0.000	3.0	0.000E+00	5.310E+05	0.0 ± 0.0
	103	899			14.1	2.872E+05	2.507E+06	

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

CHI SQUARED = 12.319 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 87.2 %
CORRELATION COEFFICIENT = 0.966
VARIANCE OF SQR(Ns) = 2.35
VARIANCE OF SQR(Ni) = 17.79

Ns/Ni = 0.115 ± 0.012
MEAN RATIO = 0.112 ± 0.018

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.323E+06cm-2; ND = 5105

POOLED AGE = 46.8 ± 4.9 Ma
MEAN AGE = 45.7 ± 7.3 Ma

Individual Age Reports - Kongakut Section

89 POS 96A - FORTRESS MTN. FM.

IRRADIATION GT067
SLIDE NUMBER 1
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	44	137	28	0.321	54.7	1.788E+06	5.567E+06	75.1 ± 13.1
2	3	9	25	0.333	4.0	1.365E+05	4.096E+05	77.9 ± 52.0
3	9	60	36	0.150	18.6	2.844E+05	1.896E+06	35.2 ± 12.6
4	3	14	72	0.214	2.2	4.741E+04	2.212E+05	50.2 ± 32.0
5	0	15	35	0.000	4.8	0.000E+00	4.876E+05	0.0 ± 0.0
6	5	16	72	0.312	2.5	7.901E+04	2.528E+05	73.1 ± 37.5
7	5	19	30	0.263	7.1	1.896E+05	7.206E+05	61.6 ± 31.0
8	7	40	50	0.175	8.9	1.593E+05	9.102E+05	41.0 ± 16.8
9	24	68	25	0.353	30.4	1.092E+06	3.095E+06	82.5 ± 19.7
10	2	12	30	0.167	4.5	7.585E+04	4.551E+05	39.1 ± 29.9
11	4	11	42	0.364	2.9	1.084E+05	2.980E+05	85.0 ± 49.7
12	6	25	50	0.240	5.6	1.365E+05	5.689E+05	56.2 ± 25.6
13	2	7	20	0.286	3.9	1.138E+05	3.982E+05	66.9 ± 53.6
14	7	39	24	0.179	18.2	3.319E+05	1.849E+06	42.1 ± 17.3
15	5	14	30	0.357	5.2	1.896E+05	5.310E+05	83.5 ± 43.5
16	19	122	56	0.156	24.3	3.860E+05	2.479E+06	36.5 ± 9.1
17	3	8	35	0.375	2.6	9.752E+04	2.601E+05	87.6 ± 59.4
18	4	12	24	0.333	5.6	1.896E+05	5.689E+05	77.9 ± 45.0
19	2	18	56	0.111	3.6	4.064E+04	3.657E+05	26.1 ± 19.5
20	7	41	32	0.171	14.3	2.489E+05	1.458E+06	40.0 ± 16.4
	161	687			9.9	2.373E+05	1.013E+06	

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

CHI SQUARED = 19.870 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 40.2 %
CORRELATION COEFFICIENT = 0.904
VARIANCE OF SQR(Ns) = 2.05
VARIANCE OF SQR(Ni) = 6.93

Ns/Ni = 0.234 ± 0.021
MEAN RATIO = 0.243 ± 0.023

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 1.334E+06cm-2; ND = 2098

POOLED AGE = 54.9 ± 5.0 Ma
MEAN AGE = 56.9 ± 5.5 Ma

89 POS 97A - FORTRESS MTN. FM.

IRRADIATION GT067
SLIDE NUMBER 2
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	15	68	24	0.221	31.7	7.111E+05	3.224E+06	51.7 ± 14.8
2	1	7	48	0.143	1.6	2.370E+04	1.659E+05	33.5 ± 35.8
3	3	8	56	0.375	1.6	6.095E+04	1.625E+05	87.6 ± 59.4
4	13	66	49	0.197	15.0	3.019E+05	1.533E+06	46.2 ± 14.1
5	39	131	20	0.298	73.2	2.219E+06	7.452E+06	69.7 ± 12.8
6	19	123	60	0.154	22.9	3.603E+05	2.332E+06	36.2 ± 9.0
7	2	10	35	0.200	3.2	6.502E+04	3.251E+05	46.9 ± 36.3
8	3	8	35	0.375	2.6	9.752E+04	2.601E+05	87.6 ± 59.4
9	1	9	45	0.111	2.2	2.528E+04	2.276E+05	26.1 ± 27.5
10	4	10	24	0.400	4.7	1.896E+05	4.741E+05	93.4 ± 55.3
11	4	22	36	0.182	6.8	1.264E+05	6.953E+05	42.6 ± 23.2
12	2	19	60	0.105	3.5	3.793E+04	3.603E+05	24.7 ± 18.4
13	3	27	35	0.111	8.6	9.752E+04	8.777E+05	26.1 ± 15.9
14	7	42	32	0.167	14.7	2.489E+05	1.493E+06	39.1 ± 16.0
15	15	75	25	0.200	33.5	6.827E+05	3.413E+06	46.9 ± 13.3
16	2	11	28	0.182	4.4	8.127E+04	4.470E+05	42.6 ± 32.8
17	1	12	35	0.083	3.8	3.251E+04	3.901E+05	19.6 ± 20.4
18	1	13	30	0.077	4.8	3.793E+04	4.930E+05	18.1 ± 18.8
19	1	9	40	0.111	2.5	2.844E+04	2.560E+05	26.1 ± 27.5
20	3	25	70	0.120	4.0	4.876E+04	4.064E+05	28.2 ± 17.2
21	2	6	16	0.333	4.2	1.422E+05	4.267E+05	77.9 ± 63.7
	141	701			9.8	1.998E+05	9.933E+05	

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

CHI SQUARED = 14.694 WITH 20 DEGREES OF FREEDOM
P(chi squared) = 79.4 %
CORRELATION COEFFICIENT = 0.938
VARIANCE OF SQR(Ns) = 1.97
VARIANCE OF SQR(Ni) = 7.91

Ns/Ni = 0.201 ± 0.019
MEAN RATIO = 0.197 ± 0.022

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 1.334E+06cm-2; ND = 2098

POOLED AGE = 47.1 ± 4.5 Ma
MEAN AGE = 46.3 ± 5.3 Ma

89 POS 98A - KONGAKUT FM.

IRRADIATION GT067
SLIDE NUMBER 3
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	60	68	28	0.882	27.1	2.438E+06	2.763E+06	204.3 ± 36.5
2	43	143	50	0.301	32.0	9.785E+05	3.254E+06	70.4 ± 12.4
3	15	61	18	0.246	37.9	9.482E+05	3.856E+06	57.6 ± 16.7
4	18	46	15	0.391	34.3	1.365E+06	3.489E+06	91.4 ± 25.5
5	11	33	25	0.333	14.7	5.006E+05	1.502E+06	77.9 ± 27.2
6	3	19	35	0.158	6.1	9.752E+04	6.177E+05	37.0 ± 23.0
7	3	17	24	0.176	7.9	1.422E+05	8.059E+05	41.4 ± 25.9
8	1	4	12	0.250	3.7	9.482E+04	3.793E+05	58.5 ± 65.5
9	1	2	24	0.500	0.9	4.741E+04	9.482E+04	116.6 ± 142.8
10	4	20	21	0.200	10.6	2.167E+05	1.084E+06	46.9 ± 25.7
11	6	24	15	0.250	17.9	4.551E+05	1.820E+06	58.5 ± 26.8
12	4	18	16	0.222	12.6	2.844E+05	1.280E+06	52.1 ± 28.8
13	0	5	36	0.000	1.6	0.000E+00	1.580E+05	0.0 ± 0.0
14	11	30	16	0.367	20.9	7.822E+05	2.133E+06	85.7 ± 30.3
15	1	8	24	0.125	3.7	4.741E+04	3.793E+05	29.3 ± 31.1
	181	498			15.5	5.736E+05	1.578E+06	

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

CHI SQUARED = 39.071 WITH 14 DEGREES OF FREEDOM
P(chi squared) = 0.0 %
CORRELATION COEFFICIENT = 0.809
VARIANCE OF SQR(Ns) = 4.54
VARIANCE OF SQR(Ni) = 7.64

Ns/Ni = 0.363 ± 0.032
MEAN RATIO = 0.293 ± 0.052

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 1.334E+06cm-2; ND = 2098

POOLED AGE = 84.9 ± 7.7 Ma
MEAN AGE = 68.7 ± 12.3 Ma

89 POS 99A - FORTRESS MTN. FM.

IRRADIATION GT067
SLIDE NUMBER 4
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	7	30	25	0.233	13.4	3.186E+05	1.365E+06	54.7 ± 23.0
2	6	29	32	0.207	10.1	2.133E+05	1.031E+06	48.5 ± 21.8
3	2	18	18	0.111	11.2	1.264E+05	1.138E+06	26.1 ± 19.5
4	66	372	30	0.177	138.5	2.503E+06	1.411E+07	41.6 ± 5.6
5	23	165	56	0.139	32.9	4.673E+05	3.352E+06	32.7 ± 7.3
6	4	12	20	0.333	6.7	2.276E+05	6.827E+05	77.9 ± 45.0
7	30	134	80	0.224	18.7	4.267E+05	1.906E+06	52.5 ± 10.7
8	22	61	16	0.361	42.6	1.564E+06	4.338E+06	84.3 ± 21.1
9	1	7	48	0.143	1.6	2.370E+04	1.659E+05	33.5 ± 35.8
10	7	11	48	0.636	2.6	1.659E+05	2.607E+05	148.0 ± 71.6
11	5	21	60	0.238	3.9	9.482E+04	3.982E+05	55.8 ± 27.8
12	2	12	25	0.167	5.4	9.102E+04	5.461E+05	39.1 ± 29.9
13	1	7	50	0.143	1.6	2.276E+04	1.593E+05	33.5 ± 35.8
14	0	7	36	0.000	2.2	0.000E+00	2.212E+05	0.0 ± 0.0
15	3	18	70	0.167	2.9	4.876E+04	2.926E+05	39.1 ± 24.4
16	29	109	25	0.266	48.7	1.320E+06	4.961E+06	62.3 ± 13.1
17	11	78	30	0.141	29.0	4.172E+05	2.958E+06	33.1 ± 10.7
18	5	36	20	0.139	20.1	2.844E+05	2.048E+06	32.6 ± 15.6
19	66	410	70	0.161	65.4	1.073E+06	6.664E+06	37.8 ± 5.1
20	14	52	25	0.269	23.2	6.372E+05	2.367E+06	63.0 ± 19.0
	304	1589			22.6	4.412E+05	2.306E+06	

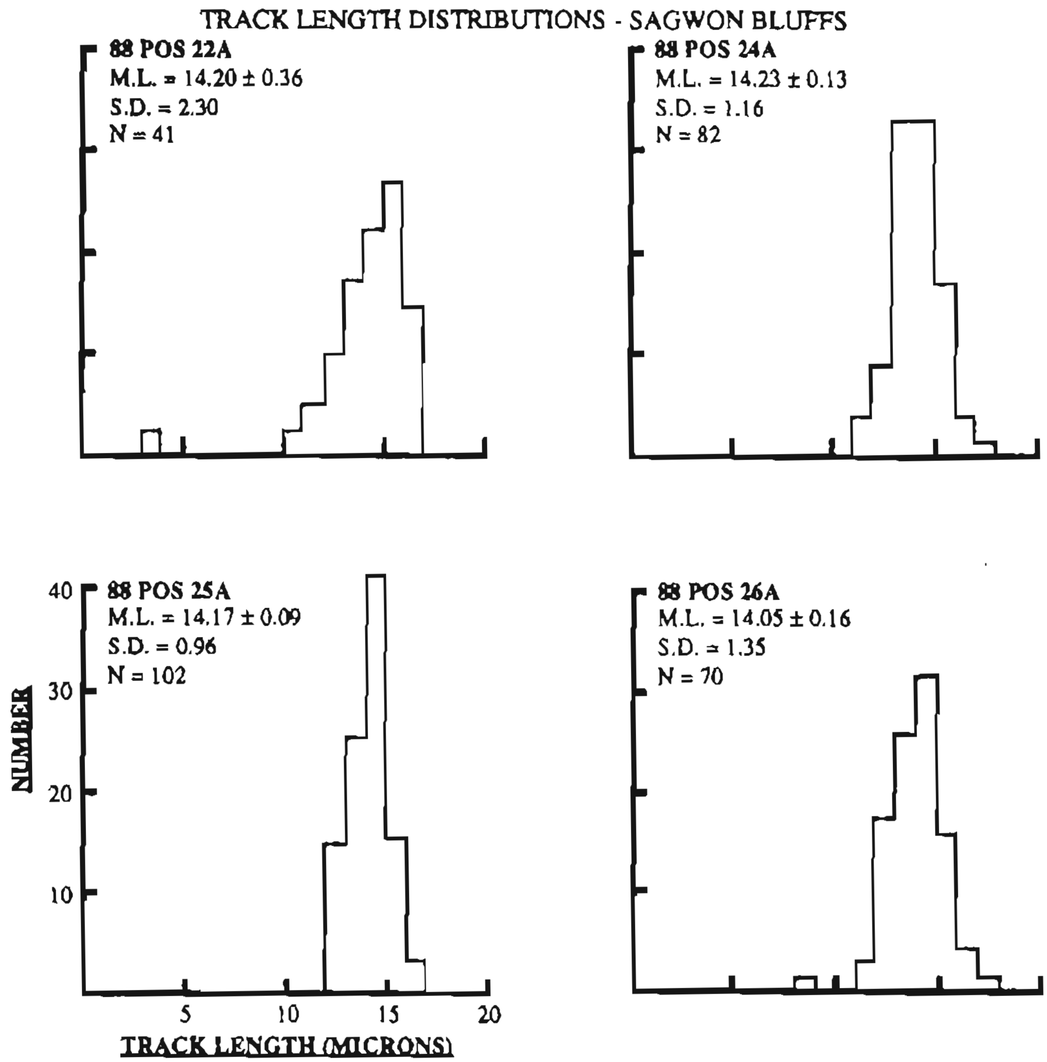
Area of basic unit = 8.789E-07 cm-2

CHI SQUARED = 27.030 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 10.4 %
CORRELATION COEFFICIENT = 0.976
VARIANCE OF SQR(Ns) = 5.08
VARIANCE OF SQR(Ni) = 27.26

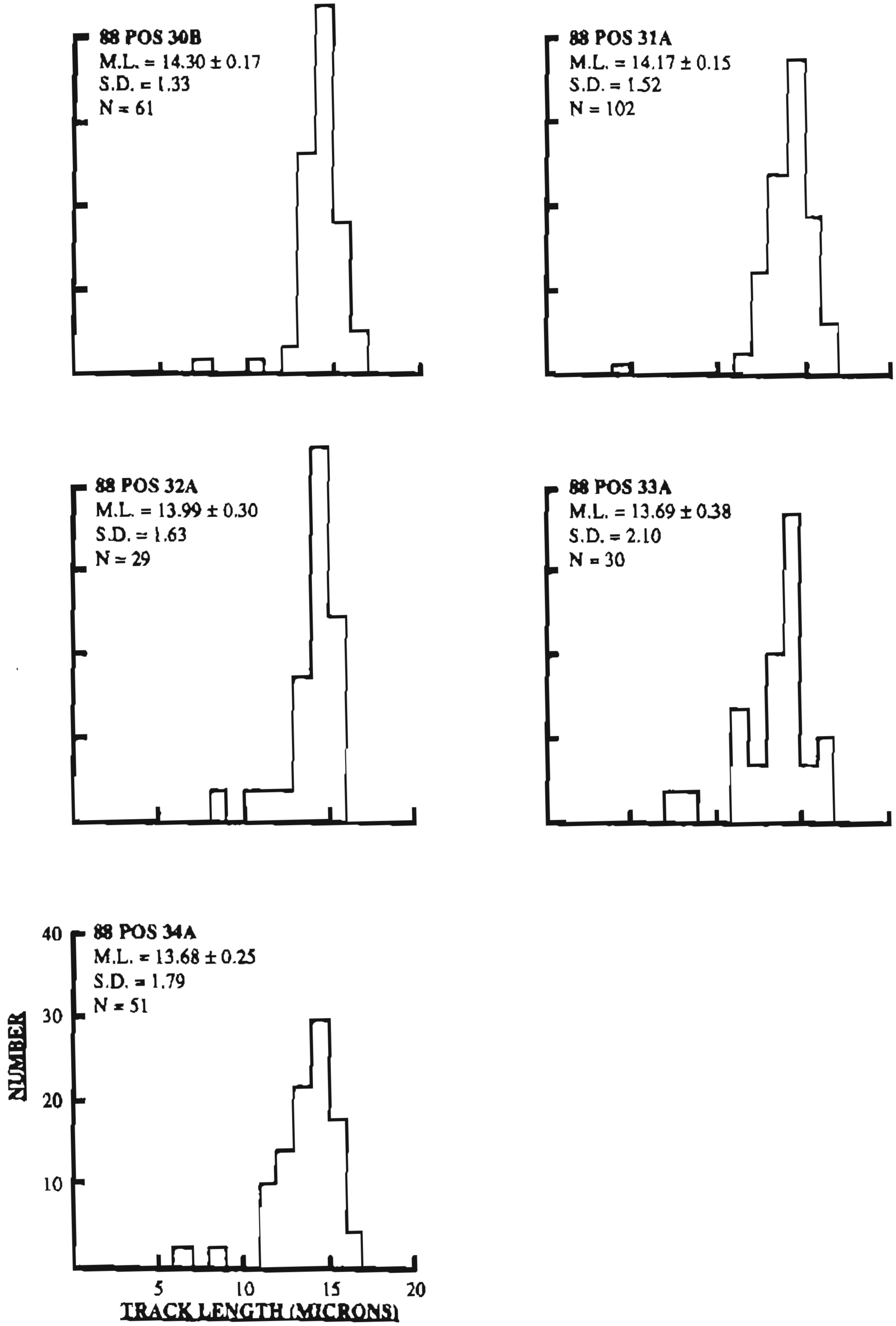
Ns/Ni = 0.191 ± 0.012
MEAN RATIO = 0.213 ± 0.029

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 1.334E+06cm-2; ND = 2098

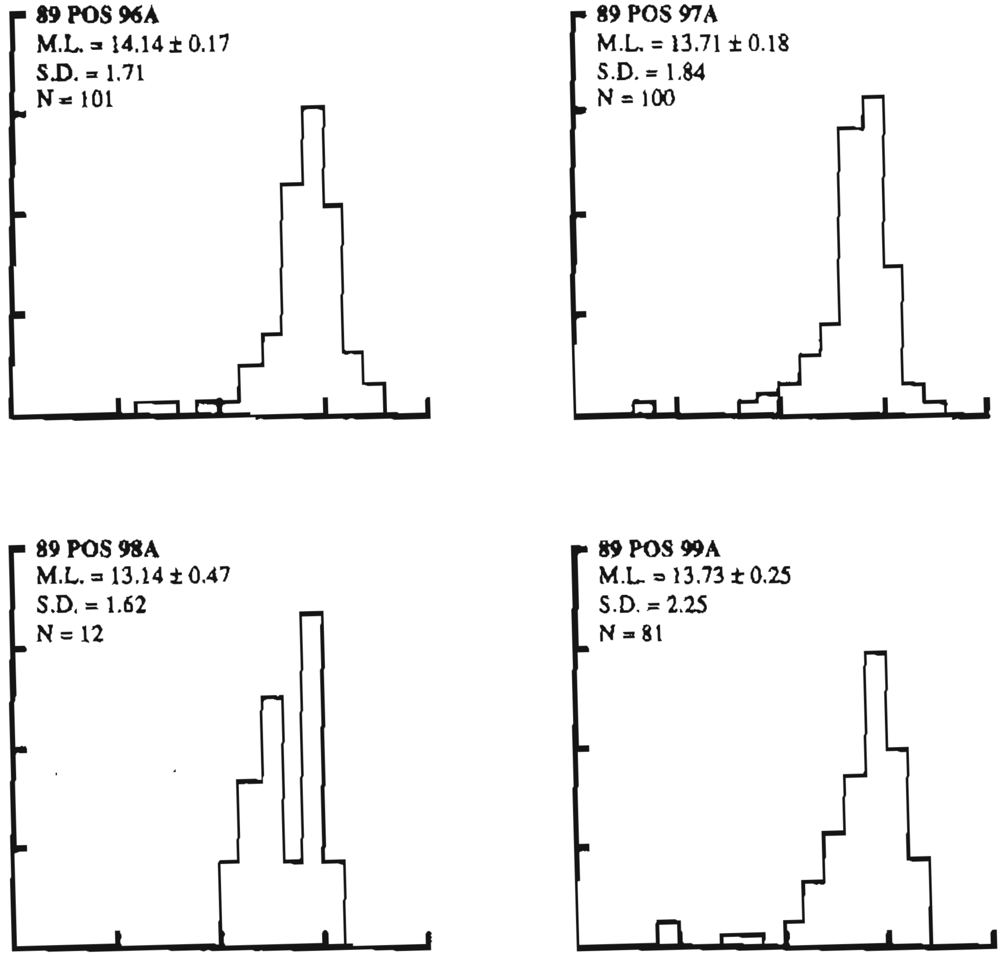
POOLED AGE = 44.8 ± 3.0 Ma
MEAN AGE = 49.9 ± 6.8 Ma


TRACK LENGTH DISTRIBUTIONS - SAGWON BLUFFS
88 POS 22A
M.L. = 14.20 ± 0.36
S.D. = 2.30
N = 41
88 POS 24A
M.L. = 14.23 ± 0.13
S.D. = 1.16
N = 82
88 POS 25A
M.L. = 14.17 ± 0.09
S.D. = 0.96
N = 102
88 POS 26A
M.L. = 14.05 ± 0.16
S.D. = 1.35
N = 70
NUMBER
40
30
20
10
5
10
15
20
TRACK LENGTH (MICRONS)

TRACK LENGTH DISTRIBUTIONS - SLOPE MOUNTAIN SECTION



TRACK LENGTH DISTRIBUTIONS - KONGAKUT SECTION



NORTH SLOPE WELLS
Sample Information

Tunalik

Sample #	Unit	Depth (ft)	Results (data)
88 POS 105A	Nanushuk Gp.	3,294	Age and Length
88 POS 106A	Nanushuk Gp.	5,558	Age and Length
88 POS 107A	Nanushuk Gp.	6,506	Age and Length
88 POS 104A	Torok Fm.	7,880	Not Dateable
88 POS 103A	Torok Fm.	9,501	Not Dateable
88 POS 101A	Kingak Shale	10,932	Age and Length
88 POS 108A	Kingak Shale	11,692	Age and Length
88 POS 99A	Ivishak Fm.	14,852	Age and Length
88 POS 102A	Sag River SS.	15,418	Age and Length
88 POS 100A	Echooka Fm.	16,946	Age only

Walakpa #1 and #2

Sample #	Unit	Depth (ft)	Results (data)
88 POS 109A	Torok Fm.	262	Age and Length
88 POS 113A	Pebble Shale	2,087	Age and Length
88 POS 110A	Pebble Shale	2,632	Age and Length
88 POS 114A	Barrow SS.	3,100	Age and Length
88 POS 115A	Argillite Basement	3,659	Age and Length
88 POS 111A	Pebble Shale	3,707	Combined w/ 112A
88 POS 112A	Pebble Shale	3,749	Age and Length

Inigok #1

Sample #	Unit	Depth (ft)	Results (data)
88 POS 127A	Nanushuk Gp.	2,632	Age and Length
88 POS 126A	Nanushuk Gp.	3,078	Age and Length
88 POS 125A	Torok Fm.	5,006	Age and Length
88 POS 124A	Torok Fm.	8,237	Age and Length
88 POS 123A	Torok Fm.	8,849	Age and Length
88 POS 122A	Kingak Shale	9,435	Age and Length
88 POS 121A	Kingak Shale	10,296	Not Dateable
88 POS 120A	Ivishak Fm.	12,501	Age Only
88 POS 119A	Ivishak Fm.	12,735	Age and Length
88 POS 118A	Echooka Fm.	13,832	Not Dateable
88 POS 117A	Kekiktuk Cong.	19,369	Age Only
88 POS 116A	Kekiktuk Cong.	20,092	Not Dateable

Alaska State C-1

Sample #	Unit	Depth (ft)	Results (data)
89 POS 19A	Sagavanirktok Fm.	3,500	Age and Length
89 POS 18A	Sagavanirktok Fm.	5,900	Not Dateable
89 POS 17A	Canning Fm.	9,150	Age and Length
89 POS 16A	Canning Fm.	11,450	Age and Length
89 POS 15A	Thompson SS.	13,000	Age and Length
89 POS 14A	Thompson SS.	13,600	Age Only

Out of 35 original samples, 29 yielded dateable apatite and 18 yielded apatite in adequate amounts for 20 individual grains to be dated. For samples where it was determined that the grains represented a single population, the pooled age is used. For samples where grains representing multiple populations are present, the mean age is presented (shown by a * in table below).

Tunalik #1

Sample No.	Unit	Lengths (#)	Mean Len. (μm)	Grains (#)	Age (Ma ± 1σ)
88 POS 105A	Tuktu Fm.	106	13.87	20	80.3 ± 6.7
88 POS 106A	Tuktu Fm.	80	13.02	20	61.4 ± 8.8
88 POS 107A	Torok Fm.	78	11.80	20	61.8 ± 6.5
88 POS 101A	Kingak Shale	9	10.00	20	24.2 ± 6.9
88 POS 108A	Kingak Shale	10	8.57	13	25.8 ± 7.1
88 POS 99A	Ivishak Fm.	20	7.39	18	9.8 ± 3.8
88 POS 102A	Sag River SS.	5	10.04	13	8.3 ± 4.2
88 POS 100A	Echooka Fm.	0	-	15	5.5 ± 2.8

Walakpa #1 and #2

Sample No.	Unit	Lengths (#)	Mean Len. (μm)	Grains (#)	Age (Ma ± 1σ)
88 POS 109A	Torok Fm.	99	13.82	41	202.4 ± 14.1*
88 POS 113A	Pebble Shale	26	11.90	20	257.4 ± 18.3
88 POS 110A	Pebble Shale	53	12.55	20	245.5 ± 26.6*
88 POS 114A	Barrow SS.	15	12.24	10	198.4 ± 31.2*
88 POS 115A	Argillite Base.	17	12.61	9	168.8 ± 23.0*
88 POS 112A	Pebble Shale	28	12.18	22	239.7 ± 24.8

Inigok #1

Sample No.	Unit	Lengths (#)	Mean Len. (μm)	Grains (#)	Age (Ma ± 1σ)
88 POS 127A	Tuktu Fm.	102	13.38	20	97.6 ± 9.5
88 POS 126A	Tuktu Fm.	102	13.13	20	97.5 ± 10.6
88 POS 125A	Torok Fm.	105	12.87	20	102.3 ± 9.5
88 POS 124A	Torok Fm.	77	12.19	20	39.4 ± 4.9
88 POS 123A	Torok Fm.	60	11.30	20	38.8 ± 6.2
88 POS 122A	Kingak Shale	27	10.68	20	49.6 ± 5.8
88 POS 120A	Ivishak Fm.	0	-	16	11.7 ± 4.5
88 POS 119A	Ivishak Fm.	6	7.56	20	13.2 ± 4.5
88 POS 117A	Kekiktuk Cong.	0	-	6	3.2 ± 3.2

Alaska State C-1

Sample No.	Unit	Lengths (#)	Mean Len. (μm)	Grains (#)	Age (Ma ± 1σ)
89 POS 19A	Sagavanirktok	31	12.14	12	81.0 ± 24.1*
89 POS 17A	Canning Fm.	21	12.27	20	100.3 ± 20.4*
89 POS 16A	Canning Fm.	41	9.93	25	82.6 ± 16.7*
89 POS 15A	Thomson SS.	26	8.79	26	53.4 ± 5.1
89 POS 14A	Thomson SS.	0	-	14	11.2 ± 5.2

Track Length Data
(by depth and well)

Tunalik #1

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
105A	0	0	0	0	0	0	3	7	14	26	38	18	0	0
106A	0	0	0	0	1	2	3	11	22	19	17	4	1	0
107A	0	0	1	1	3	6	10	15	21	16	4	1	0	0
101A	0	0	0	0	1	4	2	2	0	0	0	0	0	0
108A	0	0	1	2	4	1	2	0	0	0	0	0	0	0
99A	3	4	5	1	1	3	0	3	0	0	0	0	0	0
102A	0	0	1	1	0	0	0	2	0	1	0	0	0	0
100A	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Walakpa #1 and #2

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
109A	0	0	0	0	0	0	3	6	17	21	37	11	4	0
113A	0	0	0	0	1	1	6	5	7	3	3	0	0	0
110A	0	0	0	0	1	1	5	12	12	13	9	0	0	0
114A	0	0	0	0	0	2	0	6	3	1	3	0	0	0
115A	0	0	0	0	0	2	1	3	2	5	3	1	0	0
111+112A	0	0	0	1	1	0	5	8	4	2	5	2	0	0

Inigok #1

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
127A	0	0	1	0	0	0	10	10	17	26	19	16	2	1
126A	0	0	0	0	1	2	7	11	26	27	14	10	4	0
125A	2	0	0	0	2	7	5	9	22	25	20	11	2	0
124A	0	0	0	0	3	2	11	16	25	14	4	0	1	1
123A	0	0	1	0	5	8	7	14	17	7	1	0	0	0
122A	0	1	0	2	2	4	8	3	3	1	2	1	0	0
120A	-	-	-	-	-	-	-	-	-	-	-	-	-	-
119A	3	0	0	0	0	0	2	1	0	0	0	0	0	0
117A	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Alaska State C-1

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
19A	0	0	0	0	5	4	2	2	4	5	4	4	1	0
17A	0	1	0	1	1	3	1	2	2	2	5	3	0	0
16A	0	0	3	2	9	11	3	6	5	2	0	0	0	0
15A	2	0	5	3	5	2	4	1	4	0	0	0	0	0
14A	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Individual Age Reports - Tunalik #1
(in numerical order)

88 POS 99A - IVISHAK FM. - 14,852'

IRRADIATION LU021 SLIDE NUMBER 01
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	17	12	0.000	9.0	0.000E+00	1.656E+06	0.0± 0.0
2	0	14	12	0.000	7.4	0.000E+00	1.364E+06	0.0± 0.0
3	0	16	14	0.000	7.3	0.000E+00	1.336E+06	0.0± 0.0
4	0	18	15	0.000	7.6	0.000E+00	1.403E+06	0.0± 0.0
5	2	16	6	0.125	17.0	3.896E+05	3.117E+06	53.0± 39.7
6	0	15	10	0.000	9.5	0.000E+00	1.753E+06	0.0± 0.0
7	1	14	15	0.071	5.9	7.792E+04	1.091E+06	30.3± 31.4
8	0	20	12	0.000	10.6	0.000E+00	1.948E+06	0.0± 0.0
9	0	18	12	0.000	9.5	0.000E+00	1.753E+06	0.0± 0.0
10	1	10	12	0.100	5.3	9.740E+04	9.740E+05	42.4± 44.5
11	0	20	15	0.000	8.5	0.000E+00	1.558E+06	0.0± 0.0
12	0	19	12	0.000	10.1	0.000E+00	1.851E+06	0.0± 0.0
13	2	24	15	0.083	10.2	1.558E+05	1.870E+06	35.4± 26.0
14	0	14	21	0.000	4.2	0.000E+00	7.792E+05	0.0± 0.0
15	0	16	12	0.000	8.5	0.000E+00	1.558E+06	0.0± 0.0
16	0	19	12	0.000	10.1	0.000E+00	1.851E+06	0.0± 0.0
17	1	17	15	0.059	7.2	7.792E+04	1.325E+06	25.0± 25.7
18	0	15	20	0.000	4.8	0.000E+00	8.766E+05	0.0± 0.0
	7	302			7.9	3.381E+04	1.459E+06	

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

CHI SQUARED = 19.44956 WITH 17 DEGREES OF FREEDOM
P(chi squared) = 30.3 %
CORRELATION COEFFICIENT = 0.097
VARIANCE OF SQR(Ns) = .3007498
VARIANCE OF SQR(Ni) = .1459386

Ns/Ni = 0.023 ± 0.009
MEAN RATIO = 0.024 ± 0.010

POOLED AGE = 9.8 ± 3.8 Ma
MEAN AGE = 10.4 ± 4.2 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.408E+06cm-2; ND = 11421

88 POS 100A - ECHOOKA FM. - 16,946'

IRRADIATION LU021 SLIDE NUMBER 02
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	16	12	0.000	8.5	0.000E+00	1.558E+06	0.0± 0.0
2	1	15	36	0.067	2.6	3.247E+04	4.870E+05	28.3± 29.2
3	0	10	6	0.000	10.6	0.000E+00	1.948E+06	0.0± 0.0
4	0	18	14	0.000	8.2	0.000E+00	1.503E+06	0.0± 0.0
5	2	33	6	0.061	35.0	3.896E+05	6.428E+06	25.7± 18.8
6	0	50	12	0.000	26.5	0.000E+00	4.870E+06	0.0± 0.0
7	1	9	14	0.111	4.1	8.348E+04	7.514E+05	47.1± 49.7
8	0	23	16	0.000	9.1	0.000E+00	1.680E+06	0.0± 0.0
9	0	19	18	0.000	6.7	0.000E+00	1.234E+06	0.0± 0.0
10	0	31	20	0.000	9.9	0.000E+00	1.812E+06	0.0± 0.0
11	0	17	12	0.000	9.0	0.000E+00	1.656E+06	0.0± 0.0
12	0	8	6	0.000	8.5	0.000E+00	1.558E+06	0.0± 0.0
13	0	20	8	0.000	15.9	0.000E+00	2.922E+06	0.0± 0.0
14	0	31	16	0.000	12.3	0.000E+00	2.264E+06	0.0± 0.0
15	0	16	8	0.000	12.7	0.000E+00	2.338E+06	0.0± 0.0
	4	316			9.8	2.292E+04	1.810E+06	

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

CHI SQUARED = 18.37251 WITH 14 DEGREES OF FREEDOM
P(chi squared) = 19.0 %
CORRELATION COEFFICIENT = 0.062
VARIANCE OF SQR(Ns) = .2302054
VARIANCE OF SQR(Ni) = 1.317921

Ns/Ni = 0.013 ± 0.006
MEAN RATIO = 0.016 ± 0.009

POOLED AGE = 5.5 ± 2.8 Ma
MEAN AGE = 6.9 ± 3.9 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.480E+06cm-2; ND = 11421

88 POS 101A - KINGAK SHALE - 10,932'

IRRADIATION LU021 SLIDE NUMBER 03
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	7	6	0.000	7.4	0.000E+00	1.364E+06	0.0± 0.0
2	1	34	15	0.029	14.4	7.792E+04	2.649E+06	12.5± 12.7
3	1	6	6	0.167	6.4	1.948E+05	1.169E+06	70.5± 76.2
4	0	12	12	0.000	6.4	0.000E+00	1.169E+06	0.0± 0.0
5	0	4	6	0.000	4.2	0.000E+00	7.792E+05	0.0± 0.0
6	1	9	9	0.111	6.4	1.299E+05	1.169E+06	47.1± 49.7
7	0	4	4	0.000	6.4	0.000E+00	1.169E+06	0.0± 0.0
8	2	13	12	0.154	6.9	1.948E+05	1.266E+06	65.1± 49.5
9	2	17	9	0.118	12.0	2.597E+05	2.208E+06	49.9± 37.3
10	0	9	6	0.000	9.5	0.000E+00	1.753E+06	0.0± 0.0
11	1	14	18	0.071	4.9	6.493E+04	9.090E+05	30.3± 31.4
12	0	7	8	0.000	5.6	0.000E+00	1.023E+06	0.0± 0.0
13	0	10	12	0.000	5.3	0.000E+00	9.740E+05	0.0± 0.0
14	1	7	8	0.143	5.6	1.461E+05	1.023E+06	60.5± 64.7
15	1	25	18	0.040	8.8	6.493E+04	1.623E+06	17.0± 17.3
16	0	5	6	0.000	5.3	0.000E+00	9.740E+05	0.0± 0.0
17	1	23	12	0.043	12.2	9.740E+04	2.240E+06	18.5± 18.9
18	1	6	8	0.167	4.8	1.461E+05	8.766E+05	70.5± 76.2
19	0	10	8	0.000	7.9	0.000E+00	1.461E+06	0.0± 0.0
20	1	15	10	0.067	9.5	1.169E+05	1.753E+06	28.3± 29.2
	13	237			7.8	7.873E+04	1.435E+06	

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

CHI SQUARED = 11.1525 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 91.9 %
CORRELATION COEFFICIENT = 0.451
VARIANCE OF SQR(Ns) = .3160219
VARIANCE OF SQR(Ni) = 1.069143

Ns/Ni = 0.055 ± 0.016
MEAN RATIO = 0.055 ± 0.014

POOLED AGE = 24.2 ± 6.9 Ma
MEAN AGE = 24.5 ± 6.3 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.507E+06cm-2; ND = 11421

88 POS 102A - SAG RIVER SS. - 15,418'

IRRADIATION LU021 SLIDE NUMBER 4
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	16	12	0.000	8.5	0.000E+00	1.558E+06	0.0± 0.0
2	1	15	6	0.067	15.9	1.948E+05	2.922E+06	28.3± 29.2
3	0	9	6	0.000	9.5	0.000E+00	1.753E+06	0.0± 0.0
4	0	19	8	0.000	15.1	0.000E+00	2.776E+06	0.0± 0.0
5	0	24	10	0.000	15.3	0.000E+00	2.805E+06	0.0± 0.0
6	1	10	6	0.100	10.6	1.948E+05	1.948E+06	42.4± 44.5
7	0	18	8	0.000	14.3	0.000E+00	2.630E+06	0.0± 0.0
8	0	19	12	0.000	10.1	0.000E+00	1.851E+06	0.0± 0.0
9	0	17	6	0.000	18.0	0.000E+00	3.312E+06	0.0± 0.0
10	0	14	8	0.000	11.1	0.000E+00	2.045E+06	0.0± 0.0
11	0	16	12	0.000	8.5	0.000E+00	1.558E+06	0.0± 0.0
12	1	15	12	0.067	7.9	9.740E+04	1.461E+06	28.3± 29.2
13	1	23	6	0.043	24.4	1.948E+05	4.480E+06	18.5± 18.9
	4	215			12.2	4.174E+04	2.244E+06	

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

CHI SQUARED = 10.29022 WITH 12 DEGREES OF FREEDOM
P(chi squared) = 59.1 %
CORRELATION COEFFICIENT = -0.127
VARIANCE OF SQR(Ns) = .2307692
VARIANCE OF SQR(Ni) = .2966563

Ns/Ni = 0.019 ± 0.009
MEAN RATIO = 0.021 ± 0.010

POOLED AGE = 8.3 ± 4.2 Ma
MEAN AGE = 9.5 ± 4.4 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.534E+06cm-2; ND = 11421

88 POS 105A - NANUSHUK GROUP - 3,294'

IRRADIATION LU021 SLIDE NUMBER 06
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	11	28	28	0.393	6.4	4.592E+05	1.169E+06	165.1± 58.8
2	7	46	15	0.152	19.5	5.454E+05	3.584E+06	64.4± 26.2
3	1	5	12	0.200	2.6	9.740E+04	4.870E+05	84.6± 92.6
4	5	31	40	0.161	4.9	1.461E+05	9.058E+05	68.3± 32.9
5	25	147	36	0.170	26.0	8.116E+05	4.772E+06	72.0± 15.6
6	1	12	9	0.083	8.5	1.299E+05	1.558E+06	35.4± 36.8
7	5	11	18	0.455	3.9	3.247E+05	7.142E+05	190.6±102.8
8	26	129	18	0.202	45.6	1.688E+06	8.376E+06	85.2± 18.4
9	9	66	15	0.136	28.0	7.013E+05	5.143E+06	57.8± 20.5
10	1	20	10	0.050	12.7	1.169E+05	2.338E+06	21.2± 21.8
11	5	31	20	0.161	9.9	2.922E+05	1.812E+06	68.3± 32.9
12	7	57	12	0.123	30.2	6.818E+05	5.552E+06	52.1± 20.9
13	3	13	12	0.231	6.9	2.922E+05	1.266E+06	97.5± 62.5
14	6	35	30	0.171	7.4	2.338E+05	1.364E+06	72.6± 32.1
15	11	42	24	0.262	11.1	5.357E+05	2.045E+06	110.5± 37.5
16	5	32	24	0.156	8.5	2.435E+05	1.558E+06	66.2± 31.8
17	7	45	30	0.156	9.5	2.727E+05	1.753E+06	65.9± 26.8
18	9	61	12	0.148	32.3	8.766E+05	5.941E+06	62.5± 22.3
19	1	17	12	0.059	9.0	9.740E+04	1.656E+06	25.0± 25.7
20	26	138	15	0.188	58.5	2.026E+06	1.075E+07	79.7± 17.1
	171	966			15.7	5.098E+05	2.880E+06	

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

CHI SQUARED = 16.1911 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 64.4 %
CORRELATION COEFFICIENT = 0.955
VARIANCE OF SQR(Ns) = 1.637335
VARIANCE OF SQR(Ni) = 7.792015

Ns/Ni = 0.177 ± 0.015
MEAN RATIO = 0.183 ± 0.022

POOLED AGE = 80.3 ± 6.7 Ma
MEAN AGE = 82.9 ± 9.9 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.588E+06cm-2; ND = 11421

88 POS 106A - NANUSHUK GROUP - 5,558'

IRRADIATION LU021 SLIDE NUMBER 07
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	3	19	28	0.158	4.3	1.252E+05	7.931E+05	66.9± 41.5
2	3	14	21	0.214	4.2	1.670E+05	7.792E+05	90.6± 57.6
3	4	20	20	0.200	6.4	2.338E+05	1.169E+06	84.6± 46.3
4	3	17	10	0.176	10.8	3.506E+05	1.987E+06	74.7± 46.8
5	6	37	12	0.162	19.6	5.844E+05	3.604E+06	68.7± 30.2
6	1	7	12	0.143	3.7	9.740E+04	6.818E+05	60.5± 64.7
7	5	58	21	0.086	17.6	2.783E+05	3.228E+06	36.6± 17.1
8	3	9	10	0.333	5.7	3.506E+05	1.052E+06	140.3± 93.6
9	1	8	12	0.125	4.2	9.740E+04	7.792E+05	53.0± 56.2
10	1	9	12	0.111	4.8	9.740E+04	8.766E+05	47.1± 49.7
11	5	58	18	0.086	20.5	3.247E+05	3.766E+06	36.6± 17.1
12	0	3	9	0.000	2.1	0.000E+00	3.896E+05	0.0± 0.0
13	1	13	15	0.077	5.5	7.792E+04	1.013E+06	32.7± 33.9
14	2	21	12	0.095	11.1	1.948E+05	2.045E+06	40.4± 29.9
15	2	12	16	0.167	4.8	1.461E+05	8.766E+05	70.5± 53.9
16	3	19	12	0.158	10.1	2.922E+05	1.851E+06	66.9± 41.5
17	4	21	20	0.190	6.7	2.338E+05	1.227E+06	80.6± 44.0
18	1	8	12	0.125	4.2	9.740E+04	7.792E+05	53.0± 56.2
19	5	41	15	0.122	17.4	3.896E+05	3.195E+06	51.7± 24.5
20	2	17	12	0.118	9.0	1.948E+05	1.656E+06	49.9± 37.3
	55	411			8.7	2.150E+05	1.607E+06	

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

CHI SQUARED = 6.974223 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 99.4 %
CORRELATION COEFFICIENT = 0.829
VARIANCE OF SQR(Ns) = .3558942
VARIANCE OF SQR(Ni) = 2.544674

Ns/Ni = 0.134 ± 0.019
MEAN RATIO = 0.142 ± 0.015

POOLED AGE = 61.4 ± 8.8 Ma
MEAN AGE = 65.3 ± 6.9 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.616E+06cm-2; ND = 11421

88 POS 107A - TOROK FM. - 6,506'

IRRADIATION LU021 SLIDE NUMBER 08
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	11	30	0.000	2.3	0.000E+00	4.285E+05	0.0± 0.0
2	1	6	24	0.167	1.6	4.870E+04	2.922E+05	70.5± 76.2
3	3	18	12	0.167	9.5	2.922E+05	1.753E+06	70.5± 44.0
4	28	280	28	0.100	63.6	1.169E+06	1.169E+07	42.4± 8.4
5	4	24	8	0.167	19.1	5.844E+05	3.506E+06	70.5± 38.1
6	3	23	15	0.130	9.7	2.338E+05	1.792E+06	55.3± 33.9
7	1	7	12	0.143	3.7	9.740E+04	6.818E+05	60.5± 64.7
8	1	10	10	0.100	6.4	1.169E+05	1.169E+06	42.4± 44.5
9	8	49	24	0.163	13.0	3.896E+05	2.386E+06	69.1± 26.4
10	11	77	18	0.143	27.2	7.142E+05	5.000E+06	60.5± 19.5
11	5	17	10	0.294	10.8	5.844E+05	1.987E+06	124.0± 63.1
12	3	22	8	0.136	17.5	4.383E+05	3.214E+06	57.8± 35.6
13	1	10	28	0.100	2.3	4.174E+04	4.174E+05	42.4± 44.5
14	3	19	12	0.158	10.1	2.922E+05	1.851E+06	66.9± 41.5
15	4	23	10	0.174	14.6	4.675E+05	2.688E+06	73.6± 39.9
16	1	8	10	0.125	5.1	1.169E+05	9.350E+05	53.0± 56.2
17	8	50	24	0.160	13.2	3.896E+05	2.435E+06	67.7± 25.8
18	5	27	12	0.185	14.3	4.870E+05	2.630E+06	78.3± 38.2
19	12	85	15	0.141	36.0	9.350E+05	6.623E+06	59.8± 18.5
20	1	10	10	0.100	6.4	1.169E+05	1.169E+06	42.4± 44.5
	103	776			15.4	3.762E+05	2.834E+06	

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

CHI SQUARED = 8.110324 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 98.6 %
CORRELATION COEFFICIENT = 0.976
VARIANCE OF SQR(Ns) = 1.391811
VARIANCE OF SQR(Ni) = 10.92243

Ns/Ni = 0.133 ± 0.014
MEAN RATIO = 0.143 ± 0.012

POOLED AGE = 61.8 ± 6.5 Ma
MEAN AGE = 66.4 ± 5.7 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.653E+06cm-2; ND = 11421

88 POS 108A - KINGAK SHALE - 11,692

IRRADIATION LU021 SLIDE NUMBER 09
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	6	44	40	0.136	7.0	1.753E+05	1.286E+06	57.8± 25.2
2	1	25	12	0.040	13.2	9.740E+04	2.435E+06	17.0± 17.3
3	0	25	15	0.000	10.6	0.000E+00	1.948E+06	0.0± 0.0
4	1	15	12	0.067	7.9	9.740E+04	1.461E+06	28.3± 29.2
5	0	19	15	0.000	8.1	0.000E+00	1.480E+06	0.0± 0.0
6	0	7	6	0.000	7.4	0.000E+00	1.364E+06	0.0± 0.0
7	1	30	15	0.033	12.7	7.792E+04	2.338E+06	14.2± 14.4
8	0	12	8	0.000	9.5	0.000E+00	1.753E+06	0.0± 0.0
9	2	19	12	0.105	10.1	1.948E+05	1.851E+06	44.6± 33.2
10	1	25	15	0.040	10.6	7.792E+04	1.948E+06	17.0± 17.3
11	1	12	10	0.083	7.6	1.169E+05	1.403E+06	35.4± 36.8
12	1	8	12	0.125	4.2	9.740E+04	7.792E+05	53.0± 56.2
13	0	15	10	0.000	9.5	0.000E+00	1.753E+06	0.0± 0.0
	14	256			8.9	8.991E+04	1.644E+06	

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

CHI SQUARED = 11.07058 WITH 12 DEGREES OF FREEDOM
P(chi squared) = 52.3 %
CORRELATION COEFFICIENT = 0.721
VARIANCE OF SQR(Ns) = .5429959
VARIANCE OF SQR(Ni) = 1.247556

Ns/Ni = 0.055 ± 0.015
MEAN RATIO = 0.048 ± 0.014

POOLED AGE = 25.8 ± 7.1 Ma
MEAN AGE = 22.9 ± 6.6 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.680E+06cm-2; ND = 11421

Individual Age Reports - Walakpa #1, #2

88 POS 109A WALAPKA #1 - 262' - Torok Fm.

IRRADIATION LU008 - SLIDE NUMBER 4 - COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	9	21	42	0.429	2.8	2.381E+05	5.556E+05	195.4 ± 77.9
2	6	24	32	0.250	4.2	2.083E+05	8.333E+05	114.7 ± 52.4
3	99	202	35	0.490	32.0	3.143E+06	6.413E+06	223.0 ± 27.7
4	18	37	50	0.486	4.1	4.000E+05	8.222E+05	221.4 ± 63.8
5	67	156	35	0.429	24.7	2.127E+06	4.952E+06	195.8 ± 28.8
6	36	39	24	0.923	9.0	1.667E+06	1.806E+06	413.7 ± 96.0
7	24	55	42	0.436	7.3	6.349E+05	1.455E+06	198.9 ± 48.8
8	9	21	50	0.429	2.3	2.000E+05	4.667E+05	195.4 ± 77.9
9	33	62	18	0.532	19.1	2.037E+06	3.827E+06	241.8 ± 52.3
10	106	227	60	0.467	21.0	1.963E+06	4.204E+06	212.6 ± 25.3
11	19	24	32	0.792	4.2	6.597E+05	8.333E+05	356.4 ± 109.7
12	138	251	32	0.550	43.5	4.792E+06	8.715E+06	249.6 ± 26.9
13	29	67	60	0.433	6.2	5.370E+05	1.241E+06	197.3 ± 44.0
14	5	13	36	0.385	2.0	1.543E+05	4.012E+05	175.6 ± 92.5
15	17	38	60	0.447	3.5	3.148E+05	7.037E+05	203.8 ± 59.6
16	33	99	50	0.333	11.0	7.333E+05	2.200E+06	152.5 ± 30.8
17	3	13	20	0.231	3.6	1.667E+05	7.222E+05	106.0 ± 67.9
18	18	38	40	0.474	5.3	5.000E+05	1.056E+06	215.6 ± 61.8
19	22	44	50	0.500	4.9	4.889E+05	9.778E+05	227.4 ± 59.5
20	5	5	24	1.000	1.2	2.315E+05	2.315E+05	447.1 ± 282.9
21	102	135	42	0.756	17.8	2.698E+06	3.571E+06	340.6 ± 45.2
22	9	79	49	0.114	8.9	2.041E+05	1.791E+06	52.5 ± 18.5
23	3	16	24	0.188	3.7	1.389E+05	7.407E+05	86.2 ± 54.3
24	9	27	40	0.333	3.7	2.500E+05	7.500E+05	152.5 ± 58.8
25	7	14	27	0.500	2.9	2.881E+05	5.761E+05	227.4 ± 105.4
26	7	15	40	0.467	2.1	1.944E+05	4.167E+05	212.5 ± 97.3
27	65	84	25	0.774	18.6	2.889E+06	3.733E+06	348.6 ± 58.0
28	20	54	32	0.370	9.4	6.944E+05	1.875E+06	169.2 ± 44.4
29	17	80	40	0.212	11.1	4.722E+05	2.222E+06	97.6 ± 26.1
30	96	310	24	0.310	71.6	4.444E+06	1.435E+07	141.8 ± 16.8
31	3	21	32	0.143	3.6	1.042E+05	7.292E+05	65.8 ± 40.6
32	8	24	60	0.333	2.2	1.481E+05	4.444E+05	152.5 ± 62.3
33	32	79	24	0.405	18.3	1.481E+06	3.657E+06	184.8 ± 38.9
34	74	258	64	0.287	22.4	1.285E+06	4.479E+06	131.4 ± 17.5
35	7	14	50	0.500	1.6	1.556E+05	3.111E+05	227.4 ± 105.4
36	50	92	36	0.543	14.2	1.543E+06	2.840E+06	246.8 ± 43.6
37	1	2	36	0.500	0.3	3.086E+04	6.173E+04	227.4 ± 278.5
38	24	76	28	0.316	15.0	9.524E+05	3.016E+06	144.6 ± 34.0
39	4	11	50	0.364	1.2	8.889E+04	2.444E+05	166.2 ± 97.1
40	7	23	16	0.304	8.0	4.861E+05	1.597E+06	139.4 ± 60.2
41	10	21	50	0.476	2.3	2.222E+05	4.667E+05	216.8 ± 83.4
	1251	2871			10.1	8.792E+05	2.018E+06	

Area of basic unit = .0000009 cm-2

Chi Squared = 113.873 with 40 degrees of freedom

P(chi squared) = 0.0 %

Correlation Coefficient = 0.909

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

Rho D = 2.625E+06cm-2; ND = 5956

POOLED AGE = 198.6 ± 7.7 Ma **MEAN AGE = 202.4 ± 14.1 Ma**

88 POS 110A WALAPKA #2 - 2632' - Pebble Shale

IRRADIATION LU008 SLIDE NUMBER 3
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	21	27	24	0.778	6.2	9.722E+05	1.250E+06	350.4 ± 102.2
2	18	68	28	0.265	13.5	7.143E+05	2.698E+06	121.4 ± 32.3
3	65	76	21	0.855	20.1	3.439E+06	4.021E+06	384.2 ± 65.3
4	27	52	16	0.519	18.0	1.875E+06	3.611E+06	236.0 ± 56.2
5	14	18	18	0.778	5.5	8.642E+05	1.111E+06	350.4 ± 125.0
6	29	41	21	0.707	10.8	1.534E+06	2.169E+06	319.4 ± 77.7
7	7	14	9	0.500	8.6	8.642E+05	1.728E+06	227.4 ± 105.4
8	11	76	15	0.145	28.1	8.148E+05	5.630E+06	66.7 ± 21.5
9	8	22	50	0.364	2.4	1.778E+05	4.889E+05	166.2 ± 68.7
10	75	182	40	0.412	25.2	2.083E+06	5.056E+06	188.0 ± 26.0
11	7	68	10	0.103	37.7	7.778E+05	7.556E+06	47.5 ± 18.9
12	16	28	24	0.571	6.5	7.407E+05	1.296E+06	259.2 ± 81.4
13	5	9	25	0.556	2.0	2.222E+05	4.000E+05	252.2 ± 140.7
14	21	41	21	0.512	10.8	1.111E+06	2.169E+06	232.8 ± 62.6
15	5	28	40	0.179	3.9	1.389E+05	7.778E+05	82.1 ± 39.9
16	14	49	21	0.286	12.9	7.407E+05	2.593E+06	130.9 ± 39.8
17	21	26	16	0.808	9.0	1.458E+06	1.806E+06	363.5 ± 106.9
18	87	126	20	0.690	34.9	4.833E+06	7.000E+06	312.0 ± 43.9
19	143	149	24	0.960	34.4	6.620E+06	6.898E+06	429.6 ± 51.0
20	42	51	28	0.824	10.1	1.667E+06	2.024E+06	370.4 ± 77.5
	636	1151			13.6	1.500E+06	2.715E+06	

Area of basic unit = .0000009 cm-2

Chi Squared = 108.325 with 19 degrees of freedom
P(chi squared) = 0.0 %
Correlation Coefficient = 0.816
Variance of SQR(Ns) = 6.92
Variance of SQR(Ni) = 7.84

Ns/Ni = 0.553 ± 0.027
Mean Ratio = 0.501 ± 0.062

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass
Rho D = 2.625E+06cm-2; ND = 5956

POOLED AGE = 250.8 ± 13.3 Ma
MEAN AGE = 245.5 ± 26.6 Ma

88 POS 111A + 88 POS 112A WALAPKA #2 - 3707'-3749' - Pebble Shale

IRRADIATION LU008 SLIDE NUMBER 2
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	17	33	20	0.515	9.1	9.444E+05	1.833E+06	234.2 ± 70.1
2	23	37	45	0.622	4.6	5.679E+05	9.136E+05	281.5 ± 74.9
3	10	19	36	0.526	2.9	3.086E+05	5.864E+05	239.1 ± 93.5
4	16	107	8	0.150	74.2	2.222E+06	1.486E+07	68.9 ± 18.5
5	19	43	18	0.442	13.2	1.173E+06	2.654E+06	201.4 ± 55.6
6	6	7	8	0.857	4.9	8.333E+05	9.722E+05	385.1 ± 214.4
7	35	38	28	0.921	7.5	1.389E+06	1.508E+06	412.9 ± 97.0
8	17	104	24	0.163	24.0	7.870E+05	4.815E+06	75.2 ± 19.7
9	25	50	21	0.500	13.2	1.323E+06	2.646E+06	227.4 ± 55.9
10	17	71	32	0.239	12.3	5.903E+05	2.465E+06	109.9 ± 29.7
11	20	35	24	0.571	8.1	9.259E+05	1.620E+06	259.2 ± 72.8
12	24	39	21	0.615	10.3	1.270E+06	2.063E+06	278.8 ± 72.5
13	17	28	18	0.607	8.6	1.049E+06	1.728E+06	275.1 ± 84.8
14	12	21	28	0.571	4.2	4.762E+05	8.333E+05	259.2 ± 93.9
15	13	51	18	0.255	15.7	8.025E+05	3.148E+06	116.9 ± 36.4
16	18	31	20	0.581	8.6	1.000E+06	1.722E+06	263.3 ± 78.2
17	7	9	28	0.778	1.8	2.778E+05	3.571E+05	350.4 ± 176.7
18	27	51	30	0.529	9.4	1.000E+06	1.889E+06	240.5 ± 57.4
19	16	103	25	0.155	22.8	7.111E+05	4.578E+06	71.5 ± 19.3
20	37	41	35	0.902	6.5	1.175E+06	1.302E+06	404.8 ± 92.1
21	41	45	21	0.911	11.9	2.169E+06	2.381E+06	408.5 ± 88.6
22	17	87	24	0.195	20.1	7.870E+05	4.028E+06	89.8 ± 23.9
	434	1050			10.9	9.064E+05	2.193E+06	

Area of basic unit = .0000009 cm-2

Chi Squared = 113.428 with 21 degrees of freedom
P(chi squared) = 0.0 %
Correlation Coefficient = 0.095
Variance of SQR(Ns) = 1.00
Variance of SQR(Ni) = 4.45

Ns/Ni = 0.413 ± 0.024
Mean Ratio = 0.466 ± 0.055

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass
Rho D = 2.625E+06cm-2; ND = 5956

POOLED AGE = 188.6 ± 11.4 Ma
MEAN AGE = 239.7 ± 24.8 Ma

88 POS 113A WALAPKA #1 - 2087' - Pebble Shale

IRRADIATION LU009 SLIDE NUMBER 15
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	30	55	15	0.545	20.3	2.222E+06	4.074E+06	247.7 ± 56.4
2	1	2	12	0.500	0.9	9.259E+04	1.852E+05	227.4 ± 278.5
3	27	45	12	0.600	20.8	2.500E+06	4.167E+06	271.9 ± 66.4
4	19	33	8	0.576	22.9	2.639E+06	4.583E+06	261.2 ± 75.4
5	14	45	10	0.311	25.0	1.556E+06	5.000E+06	142.4 ± 43.7
6	7	8	8	0.875	5.5	9.722E+05	1.111E+06	392.8 ± 203.5
7	54	98	12	0.551	45.3	5.000E+06	9.074E+06	250.2 ± 42.7
8	10	20	10	0.500	11.1	1.111E+06	2.222E+06	227.4 ± 88.2
9	2	9	12	0.222	4.2	1.852E+05	8.333E+05	102.1 ± 79.8
10	10	14	16	0.714	4.9	6.944E+05	9.722E+05	322.5 ± 133.7
11	5	15	12	0.333	6.9	4.630E+05	1.389E+06	152.5 ± 78.8
12	8	23	12	0.348	10.6	7.407E+05	2.130E+06	159.0 ± 65.4
13	2	5	18	0.400	1.5	1.235E+05	3.086E+05	182.6 ± 152.8
14	6	11	12	0.545	5.1	5.556E+05	1.019E+06	247.7 ± 125.8
15	38	51	28	0.745	10.1	1.508E+06	2.024E+06	336.0 ± 72.3
16	8	17	15	0.471	6.3	5.926E+05	1.259E+06	214.2 ± 91.9
17	17	31	21	0.548	8.2	8.995E+05	1.640E+06	249.0 ± 75.3
18	9	13	28	0.692	2.6	3.571E+05	5.159E+05	312.8 ± 135.8
19	21	28	12	0.750	12.9	1.944E+06	2.593E+06	338.2 ± 97.8
20	45	64	56	0.703	6.3	8.929E+05	1.270E+06	317.5 ± 62.1
	333	587			9.9	1.125E+06	1.982E+06	

Area of basic unit = .0000009 cm-2

Chi Squared = 13.695 with 19 degrees of freedom
P(chi squared) = 80.1 %
Correlation Coefficient = 0.954
Variance of SQR(Ns) = 3.18
Variance of SQR(Ni) = 4.64

Ns/Ni = 0.567 ± 0.039
Mean Ratio = 0.567 ± 0.039

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass
Rho D = 2.625E+06cm-2; ND = 5855

POOLED AGE = 257.4 ± 18.3 Ma
MEAN AGE = 248.2 ± 17.8 Ma

88 POS 114A WALAPKA #1 - 3100' - Barrow SS.

IRRADIATION LU009 SLIDE NUMBER 14
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	80	81	20	0.988	22.5	4.444E+06	4.500E+06	441.7 ± 70.1
2	5	9	14	0.556	3.6	3.968E+05	7.143E+05	252.2 ± 140.7
3	17	34	18	0.500	10.5	1.049E+06	2.099E+06	227.4 ± 67.7
4	17	49	16	0.347	17.0	1.181E+06	3.403E+06	158.6 ± 44.8
5	4	10	12	0.400	4.6	3.704E+05	9.259E+05	182.6 ± 108.1
6	8	27	21	0.296	7.1	4.233E+05	1.429E+06	135.7 ± 54.7
7	14	51	32	0.274	8.8	4.861E+05	1.771E+06	125.8 ± 38.0
8	26	89	36	0.292	13.7	8.025E+05	2.747E+06	133.8 ± 29.9
9	18	48	28	0.375	9.5	7.143E+05	1.905E+06	171.3 ± 47.5
10	22	68	20	0.324	18.9	1.222E+06	3.778E+06	148.1 ± 36.4
	211	466			11.9	1.080E+06	2.386E+06	

Area of basic unit = .0000009 cm-2

Chi Squared = 37.162 with 9 degrees of freedom
P(chi squared) = 0.0 %
Correlation Coefficient = 0.694
Variance of SQR(Ns) = 3.82
Variance of SQR(Ni) = 4.92

Ns/Ni = 0.453 ± 0.038
Mean Ratio = 0.415 ± 0.064

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass
Rho D = 2.625E+06cm-2; ND = 5855

POOLED AGE = 206.3 ± 17.6 Ma
MEAN AGE = 198.4 ± 31.2 Ma

88 POS 115A WALAPKA #1 - 3659' - Argillite Basement

IRRADIATION LU009 SLIDE NUMBER 13
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	29	124	25	0.234	27.5	1.289E+06	5.511E+06	107.4 ± 22.2
2	16	24	15	?.667	8.9	1.185E+06	1.778E+06	301.5 ± 97.5
3	5	6	6	0.833	5.5	9.259E+05	1.111E+06	374.7 ± 227.0
4	3	4	10	0.750	2.2	3.333E+05	4.444E+05	338.2 ± 258.4
5	1	3	6	0.333	2.8	1.852E+05	5.556E+05	152.5 ± 176.1
6	11	13	16	0.846	4.5	7.639E+05	9.028E+05	380.3 ± 156.0
7	2	8	16	0.250	2.8	1.389E+05	5.556E+05	114.7 ± 90.7
8	5	8	9	0.625	4.9	6.173E+05	9.877E+05	283.0 ± 161.4
9	3	13	9	0.231	8.0	3.704E+05	1.605E+06	106.0 ± 67.9
	75	203			10.0	7.440E+05	2.014E+06	

Area of basic unit = .0000009 cm-2

Chi Squared = 17.252 with 8 degrees of freedom
P(chi squared) = 2.8 %
Correlation Coefficient = 0.913
Variance of SQR(Ns) = 1.99
Variance of SQR(Ni) = 8.28

Ns/Ni = 0.369 ± 0.050
Mean Ratio = 0.463 ± 0.097

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass
Rho D = 2.625E+06cm-2; ND = 5855

POOLED AGE = 168.8 ± 23.0 Ma
MEAN AGE = 240.7 ± 40.4 Ma

Individual Age Reports - Inigok #1
(in numerical order)

88 POS 117A - KEKIKTUK CONG. - 19,369'

IRRADIATION LU023 SLIDE NUMBER 04
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	16	12	0.000	7.6	0.000E+00	1.558E+06	0.0± 0.0
2	0	15	30	0.000	2.9	0.000E+00	5.844E+05	0.0± 0.0
3	0	10	6	0.000	9.6	0.000E+00	1.948E+06	0.0± 0.0
4	0	18	14	0.000	7.4	0.000E+00	1.503E+06	0.0± 0.0
5	0	33	12	0.000	15.8	0.000E+00	3.214E+06	0.0± 0.0
6	1	50	12	0.020	23.9	9.740E+04	4.870E+06	9.4± 9.5
	1	142			9.5	1.359E+04	1.930E+06	

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

CHI SQUARED = 1.816625 WITH 5 DEGREES OF FREEDOM
P(chi squared) = 87.4 %
CORRELATION COEFFICIENT = 0.857
VARIANCE OF SQR(Ns) = .1666667
VARIANCE OF SQR(Ni) = 2.091782

Ns/Ni = 0.007 ± 0.007
MEAN RATIO = 0.003 ± 0.003

POOLED AGE = 3.2 ± 3.2 Ma
MEAN AGE = 1.5 ± 1.5 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.573E+06cm-2; ND = 11864

88 POS 119A - FIRE CREEK SS. - 12,735'

IRRADIATION LU023 SLIDE NUMBER 05
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	16	20	0.000	4.6	0.000E+00	9.350E+05	0.0± 0.0
2	1	10	9	0.100	6.4	1.299E+05	1.299E+06	47.0± 49.3
3	0	5	9	0.000	3.2	0.000E+00	6.493E+05	0.0± 0.0
4	0	10	12	0.000	4.8	0.000E+00	9.740E+05	0.0± 0.0
5	0	35	20	0.000	10.0	0.000E+00	2.045E+06	0.0± 0.0
6	2	31	12	0.065	14.8	1.948E+05	3.019E+06	30.4± 22.2
7	0	8	8	0.000	5.7	0.000E+00	1.169E+06	0.0± 0.0
8	1	20	12	0.050	9.6	9.740E+04	1.948E+06	23.5± 24.1
9	2	20	16	0.100	7.2	1.461E+05	1.461E+06	47.0± 34.9
10	0	16	12	0.000	7.6	0.000E+00	1.558E+06	0.0± 0.0
11	0	9	9	0.000	5.7	0.000E+00	1.169E+06	0.0± 0.0
12	0	15	16	0.000	5.4	0.000E+00	1.096E+06	0.0± 0.0
13	1	19	16	0.053	6.8	7.305E+04	1.388E+06	24.8± 25.4
14	1	36	20	0.028	10.3	5.844E+04	2.104E+06	13.1± 13.3
15	0	14	18	0.000	4.5	0.000E+00	9.090E+05	0.0± 0.0
16	0	9	12	0.000	4.3	0.000E+00	8.766E+05	0.0± 0.0
17	0	10	12	0.000	4.8	0.000E+00	9.740E+05	0.0± 0.0
18	0	5	9	0.000	3.2	0.000E+00	6.493E+05	0.0± 0.0
19	1	17	12	0.059	8.1	9.740E+04	1.656E+06	27.7± 28.5
20	0	8	9	0.000	5.1	0.000E+00	1.039E+06	0.0± 0.0
	9	313			6.8	4.000E+04	1.391E+06	

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

CHI SQUARED = 11.87335 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 89.1 %
CORRELATION COEFFICIENT = 0.527
VARIANCE OF SQR(Ns) = .3124098
VARIANCE OF SQR(Ni) = 1.217401

Ns/Ni = 0.029 ± 0.010
MEAN RATIO = 0.023 ± 0.008

POOLED AGE = 13.2 ± 4.5 Ma
MEAN AGE = 10.4 ± 3.6 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.605E+06cm-2; ND = 11864

88 POS 120A - FIRE CREEK SS. - 12,501'

IRRADIATION LU023 SLIDE NUMBER 06
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	1	35	20	0.029	10.0	5.844E+04	2.045E+06	13.5± 13.7
2	1	20	16	0.050	7.2	7.305E+04	1.461E+06	23.5± 24.1
3	0	14	16	0.000	5.0	0.000E+00	1.023E+06	0.0± 0.0
4	0	10	9	0.000	6.4	0.000E+00	1.299E+06	0.0± 0.0
5	0	15	12	0.000	7.2	0.000E+00	1.461E+06	0.0± 0.0
6	1	21	16	0.048	7.5	7.305E+04	1.534E+06	22.4± 23.0
7	2	19	12	0.105	9.1	1.948E+05	1.851E+06	49.5± 36.8
8	0	9	8	0.000	6.5	0.000E+00	1.315E+06	0.0± 0.0
9	0	30	12	0.000	14.3	0.000E+00	2.922E+06	0.0± 0.0
10	0	36	20	0.000	10.3	0.000E+00	2.104E+06	0.0± 0.0
11	0	9	12	0.000	4.3	0.000E+00	8.766E+05	0.0± 0.0
12	0	6	9	0.000	3.8	0.000E+00	7.792E+05	0.0± 0.0
13	1	9	9	0.111	5.7	1.299E+05	1.169E+06	52.2± 55.0
14	0	17	20	0.000	4.9	0.000E+00	9.935E+05	0.0± 0.0
15	1	17	12	0.059	8.1	9.740E+04	1.656E+06	27.7± 28.5
16	0	12	9	0.000	7.6	0.000E+00	1.558E+06	0.0± 0.0
	7	279			7.5	3.859E+04	1.538E+06	

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

CHI SQUARED = 12.37848 WITH 15 DEGREES OF FREEDOM
P(chi squared) = 65.0 %
CORRELATION COEFFICIENT = 0.206
VARIANCE OF SQR(Ns) = .2952411
VARIANCE OF SQR(Ni) = 1.134424

Ns/Ni = 0.025 ± 0.010
MEAN RATIO = 0.025 ± 0.010

POOLED AGE = 11.7 ± 4.5 Ma
MEAN AGE = 11.7 ± 4.5 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.637E+06cm-2; ND = 11864

88 POS 122A - KINGAK SHALE - 9,435'

IRRADIATION LU023 SLIDE NUMBER 08
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	13	8	0.000	9.3	0.000E+00	1.899E+06	0.0± 0.0
2	1	12	12	0.083	5.7	9.740E+04	1.169E+06	39.2± 40.8
3	3	7	6	0.429	6.7	5.844E+05	1.364E+06	199.1±137.4
4	2	31	6	0.065	29.6	3.896E+05	6.039E+06	30.4± 22.2
5	14	91	10	0.154	52.2	1.636E+06	1.064E+07	72.2± 20.7
6	3	24	12	0.125	11.5	2.922E+05	2.338E+06	58.7± 36.0
7	15	95	12	0.158	45.4	1.461E+06	9.253E+06	74.1± 20.6
8	0	14	8	0.000	10.0	0.000E+00	2.045E+06	0.0± 0.0
9	1	25	6	0.040	23.9	1.948E+05	4.870E+06	18.8± 19.2
10	13	83	15	0.157	31.7	1.013E+06	6.467E+06	73.5± 21.9
11	0	14	16	0.000	5.0	0.000E+00	1.023E+06	0.0± 0.0
12	0	4	6	0.000	3.8	0.000E+00	7.792E+05	0.0± 0.0
13	0	6	10	0.000	3.4	0.000E+00	7.013E+05	0.0± 0.0
14	1	16	9	0.062	10.2	1.299E+05	2.078E+06	29.4± 30.3
15	1	11	6	0.091	10.5	1.948E+05	2.143E+06	42.7± 44.6
16	10	86	6	0.116	82.2	1.948E+06	1.675E+07	54.6± 18.3
17	7	95	30	0.074	18.2	2.727E+05	3.701E+06	34.7± 13.6
18	0	15	9	0.000	9.6	0.000E+00	1.948E+06	0.0± 0.0
19	5	74	12	0.068	35.4	4.870E+05	7.207E+06	31.8± 14.7
20	5	59	12	0.085	28.2	4.870E+05	5.746E+06	39.9± 18.6
	81	775			21.1	4.487E+05	4.293E+06	

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

CHI SQUARED = 21.58282 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 30.6 %
CORRELATION COEFFICIENT = 0.909
VARIANCE OF SQR(Ns) = 1.834569
VARIANCE OF SQR(Ni) = 7.775956

Ns/Ni = 0.105 ± 0.012
MEAN RATIO = 0.085 ± 0.022

POOLED AGE = 49.6 ± 5.8 Ma
MEAN AGE = 40.5 ± 10.4 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.701E+06cm-2; ND = 11864

88 POS 123A - TOROK FM. - 8,849'

IRRADIATION LU023 SLIDE NUMBER 09
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	23	24	0.000	5.5	0.000E+00	1.120E+06	0.0± 0.0
2	1	32	16	0.031	11.5	7.305E+04	2.338E+06	14.7± 15.0
3	3	72	20	0.042	20.7	1.753E+05	4.208E+06	19.6± 11.6
4	1	10	12	0.100	4.8	9.740E+04	9.740E+05	47.0± 49.3
5	0	4	12	0.000	1.9	0.000E+00	3.896E+05	0.0± 0.0
6	1	8	16	0.125	2.9	7.305E+04	5.844E+05	58.7± 62.3
7	3	31	15	0.097	11.9	2.338E+05	2.415E+06	45.5± 27.5
8	2	20	20	0.100	5.7	1.169E+05	1.169E+06	47.0± 34.9
9	6	61	40	0.098	8.7	1.753E+05	1.782E+06	46.2± 19.8
10	3	21	30	0.143	4.0	1.169E+05	8.181E+05	67.0± 41.4
11	2	22	16	0.091	7.9	1.461E+05	1.607E+06	42.7± 31.6
12	0	11	20	0.000	3.2	0.000E+00	6.428E+05	0.0± 0.0
13	5	34	40	0.147	4.9	1.461E+05	9.935E+05	69.0± 33.1
14	6	62	30	0.097	11.9	2.338E+05	2.415E+06	45.5± 19.5
15	2	25	16	0.080	9.0	1.461E+05	1.826E+06	37.6± 27.7
16	1	8	20	0.125	2.3	5.844E+04	4.675E+05	58.7± 62.3
17	1	8	12	0.125	3.8	9.740E+04	7.792E+05	58.7± 62.3
18	3	32	40	0.094	4.6	8.766E+04	9.350E+05	44.1± 26.6
19	2	21	18	0.095	6.7	1.299E+05	1.364E+06	44.8± 33.1
20	0	15	20	0.000	4.3	0.000E+00	8.766E+05	0.0± 0.0
	42	520			6.8	1.123E+05	1.391E+06	

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

CHI SQUARED = 10.28085 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 94.6 %
CORRELATION COEFFICIENT = 0.777
VARIANCE OF SQR(Ns) = .602412
VARIANCE OF SQR(Ni) = 3.195221

Ns/Ni = 0.081 ± 0.013
MEAN RATIO = 0.079 ± 0.011

POOLED AGE = 38.8 ± 6.2 Ma
MEAN AGE = 38.2 ± 5.3 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.733E+06cm-2; ND = 11864

88 POS 124A - TOROK FM. - 8,237'

IRRADIATION LU023 SLIDE NUMBER 10
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	3	27	12	0.111	12.9	2.922E+05	2.630E+06	52.2± 31.8
2	0	20	15	0.000	7.6	0.000E+00	1.558E+06	0.0± 0.0
3	7	102	16	0.069	36.6	5.113E+05	7.451E+06	32.3± 12.6
4	2	9	21	0.222	2.5	1.113E+05	5.009E+05	104.0± 81.3
5	5	53	12	0.094	25.3	4.870E+05	5.162E+06	44.4± 20.8
6	0	15	27	0.000	3.2	0.000E+00	6.493E+05	0.0± 0.0
7	9	58	20	0.155	16.6	5.259E+05	3.389E+06	72.8± 26.1
8	2	14	50	0.143	1.6	4.675E+04	3.273E+05	67.0± 50.7
9	6	128	15	0.047	49.0	4.675E+05	9.974E+06	22.1± 9.2
10	3	15	9	0.200	9.6	3.896E+05	1.948E+06	93.7± 59.3
11	0	16	24	0.000	3.8	0.000E+00	7.792E+05	0.0± 0.0
12	6	130	30	0.046	24.9	2.338E+05	5.065E+06	21.7± 9.1
13	2	13	40	0.154	1.9	5.844E+04	3.798E+05	72.2± 54.8
14	9	68	20	0.132	19.5	5.259E+05	3.974E+06	62.1± 22.1
15	0	12	25	0.000	2.8	0.000E+00	5.610E+05	0.0± 0.0
16	5	61	14	0.082	25.0	4.174E+05	5.092E+06	38.6± 17.9
17	2	15	20	0.133	4.3	1.169E+05	8.766E+05	62.6± 47.1
18	7	90	15	0.078	34.4	5.454E+05	7.013E+06	36.6± 14.4
19	0	12	18	0.000	3.8	0.000E+00	7.792E+05	0.0± 0.0
20	3	26	12	0.115	12.4	2.922E+05	2.532E+06	54.2± 33.1
	71	884			12.2	2.000E+05	2.490E+06	

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

CHI SQUARED = 21.8865 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 29.0 %
CORRELATION COEFFICIENT = 0.765
VARIANCE OF SQR(Ns) = 1.123067
VARIANCE OF SQR(Ni) = 8.050961

Ns/Ni = 0.080 ± 0.010
MEAN RATIO = 0.089 ± 0.015

POOLED AGE = 39.4 ± 4.9 Ma
MEAN AGE = 43.7 ± 7.6 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.789E+06cm-2; ND = 11864

88 POS 125A - TOROK FM. - 5,006'

IRRADIATION LU023 SLIDE NUMBER 11
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	6	21	40	0.286	3.0	1.753E+05	6.136E+05	133.4± 61.8
2	5	22	50	0.227	2.5	1.169E+05	5.143E+05	106.3± 52.7
3	15	78	40	0.192	11.2	4.383E+05	2.279E+06	90.1± 25.4
4	4	19	24	0.211	4.5	1.948E+05	9.253E+05	98.6± 54.2
5	4	15	24	0.267	3.6	1.948E+05	7.305E+05	124.6± 70.1
6	5	21	40	0.238	3.0	1.461E+05	6.136E+05	111.4± 55.4
7	29	152	25	0.191	34.9	1.356E+06	7.106E+06	89.4± 18.2
8	2	15	12	0.133	7.2	1.948E+05	1.461E+06	62.6± 47.1
9	5	22	21	0.227	6.0	2.783E+05	1.224E+06	106.3± 52.7
10	6	60	40	0.100	8.6	1.753E+05	1.753E+06	47.0± 20.1
11	5	18	42	0.278	2.5	1.391E+05	5.009E+05	129.7± 65.6
12	4	20	40	0.200	2.9	1.169E+05	5.844E+05	93.7± 51.3
13	5	22	40	0.227	3.2	1.461E+05	6.428E+05	106.3± 52.7
14	6	23	30	0.261	4.4	2.338E+05	8.961E+05	121.9± 55.9
15	6	20	30	0.300	3.8	2.338E+05	7.792E+05	140.0± 65.2
16	2	13	40	0.154	1.9	5.844E+04	3.798E+05	72.2± 54.8
17	4	15	50	0.267	1.7	9.350E+04	3.506E+05	124.6± 70.1
18	4	16	40	0.250	2.3	1.169E+05	4.675E+05	116.9± 65.4
19	8	29	30	0.276	5.5	3.117E+05	1.130E+06	128.8± 51.5
20	5	21	30	0.238	4.0	1.948E+05	8.181E+05	111.4± 55.4
	130	622			5.2	2.208E+05	1.057E+06	

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

CHI SQUARED = 6.736065 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 99.5 %
CORRELATION COEFFICIENT = 0.964
VARIANCE OF SQR(Ns) = .746221
VARIANCE OF SQR(Ni) = 4.450305

Ns/Ni = 0.209 ± 0.020
MEAN RATIO = 0.226 ± 0.012

POOLED AGE = 102.3 ± 9.9 Ma
MEAN AGE = 110.6 ± 5.8 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.797E+06cm-2; ND = 11864

88 POS 126A - NANUSHUK GROUP - 3,078'

IRRADIATION LU023 SLIDE NUMBER 12
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	12	40	40	0.300	5.7	3.506E+05	1.169E+06	140.0± 46.1
2	5	22	50	0.227	2.5	1.169E+05	5.143E+05	106.3± 52.7
3	7	21	12	0.333	10.0	6.818E+05	2.045E+06	155.4± 67.8
4	4	20	24	0.200	4.8	1.948E+05	9.740E+05	93.7± 51.3
5	2	15	18	0.133	4.8	1.299E+05	9.740E+05	62.6± 47.1
6	5	22	15	0.227	8.4	3.896E+05	1.714E+06	106.3± 52.7
7	6	27	15	0.222	10.3	4.675E+05	2.104E+06	104.0± 47.0
8	2	12	12	0.167	5.7	1.948E+05	1.169E+06	78.1± 59.7
9	9	45	18	0.200	14.3	5.844E+05	2.922E+06	93.7± 34.2
10	6	45	40	0.133	6.5	1.753E+05	1.315E+06	62.6± 27.2
11	8	54	30	0.148	10.3	3.117E+05	2.104E+06	69.5± 26.4
12	4	20	36	0.200	3.2	1.299E+05	6.493E+05	93.7± 51.3
13	4	35	36	0.114	5.6	1.299E+05	1.136E+06	53.7± 28.3
14	6	24	30	0.250	4.6	2.338E+05	9.350E+05	116.9± 53.4
15	2	10	28	0.200	2.0	8.348E+04	4.174E+05	93.7± 72.6
16	2	10	40	0.200	1.4	5.844E+04	2.922E+05	93.7± 72.6
17	6	41	16	0.146	14.7	4.383E+05	2.995E+06	68.7± 30.0
18	4	16	40	0.250	2.3	1.169E+05	4.675E+05	116.9± 65.4
19	3	20	12	0.150	9.6	2.922E+05	1.948E+06	70.4± 43.6
20	5	19	30	0.263	3.6	1.948E+05	7.402E+05	123.0± 61.8
	102	518			5.5	2.200E+05	1.117E+06	

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

CHI SQUARED = 7.63678 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 99.0 %
CORRELATION COEFFICIENT = 0.757
VARIANCE OF SQR(Ns) = .3122036
VARIANCE OF SQR(Ni) = 1.520991

Ns/Ni = 0.197 ± 0.021
MEAN RATIO = 0.203 ± 0.013

POOLED AGE = 97.5 ± 10.6 Ma
MEAN AGE = 100.6 ± 6.5 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.829E+06cm-2; ND = 11864

88 POS 127A - NANUSHUK GROUP - 2,632'

IRRADIATION LU023 SLIDE NUMBER 13
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	4	14	24	0.286	3.3	1.948E+05	6.818E+05	133.4± 75.7
2	12	41	40	0.293	5.9	3.506E+05	1.198E+06	136.6± 44.9
3	5	29	16	0.172	10.4	3.652E+05	2.118E+06	80.8± 39.2
4	7	21	12	0.333	10.0	6.818E+05	2.045E+06	155.4± 67.8
5	9	24	36	0.375	3.8	2.922E+05	7.792E+05	174.5± 68.3
6	2	16	18	0.125	5.1	1.299E+05	1.039E+06	58.7± 44.0
7	16	77	21	0.208	21.0	8.905E+05	4.285E+06	97.3± 26.8
8	6	28	15	0.214	10.7	4.675E+05	2.182E+06	100.3± 45.1
9	4	43	21	0.093	11.7	2.226E+05	2.393E+06	43.7± 22.9
10	9	41	18	0.220	13.1	5.844E+05	2.662E+06	102.7± 37.8
11	10	41	36	0.244	6.5	3.247E+05	1.331E+06	114.0± 40.3
12	8	71	30	0.113	13.6	3.117E+05	2.766E+06	52.9± 19.8
13	2	14	8	0.143	10.0	2.922E+05	2.045E+06	67.0± 50.7
14	4	38	36	0.105	6.1	1.299E+05	1.234E+06	49.5± 26.0
15	9	40	20	0.225	11.5	5.259E+05	2.338E+06	105.3± 38.9
16	2	15	28	0.133	3.1	8.348E+04	6.261E+05	62.6± 47.1
17	6	25	10	0.240	14.3	7.013E+05	2.922E+06	112.2± 51.0
18	6	42	15	0.143	16.1	4.675E+05	3.273E+06	67.0± 29.3
19	4	18	30	0.222	3.4	1.558E+05	7.013E+05	104.0± 57.5
20	3	19	12	0.158	9.1	2.922E+05	1.851E+06	74.1± 46.0
	128	657			8.4	3.354E+05	1.722E+06	

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

CHI SQUARED = 14.7022 WITH 19 DEGREES OF FREEDOM
P(chi squared) = 74.1 %
CORRELATION COEFFICIENT = 0.736
VARIANCE OF SQR(Ns) = .5058557
VARIANCE OF SQR(Ni) = 2.123895

Ns/Ni = 0.195 ± 0.019
MEAN RATIO = 0.202 ± 0.018

POOLED AGE = 97.6 ± 9.5 Ma
MEAN AGE = 101.2 ± 8.8 Ma

Ages calculated using a zeta of 352.7 ± 3.9 for SRM612 glass
RHO D = 2.861E+06cm-2; ND = 11864

Individual Age Reports - Alaska State C-1
(in numerical order)

89 POS 14A 13,600' - THOMPSON SS.

IRRADIATION LU059 SLIDE NUMBER 13
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	0	5	8	0.000	7.4	0.000E+00	6.944E+05	0.0 ± 0.0
2	0	4	4	0.000	11.9	0.000E+00	1.111E+06	0.0 ± 0.0
3	0	12	12	0.000	11.9	0.000E+00	1.111E+06	0.0 ± 0.0
4	1	7	10	0.143	8.3	1.111E+05	7.778E+05	30.8 ± 32.9
5	0	4	6	0.000	7.9	0.000E+00	7.407E+05	0.0 ± 0.0
6	0	3	4	0.000	8.9	0.000E+00	8.333E+05	0.0 ± 0.0
7	2	14	18	0.143	9.2	1.235E+05	8.642E+05	30.8 ± 23.3
8	0	7	9	0.000	9.2	0.000E+00	8.642E+05	0.0 ± 0.0
9	0	3	4	0.000	8.9	0.000E+00	8.333E+05	0.0 ± 0.0
10	0	4	6	0.000	7.9	0.000E+00	7.407E+05	0.0 ± 0.0
11	1	6	6	0.167	11.9	1.852E+05	1.111E+06	35.9 ± 38.8
12	0	7	12	0.000	6.9	0.000E+00	6.481E+05	0.0 ± 0.0
13	1	11	8	0.091	16.3	1.389E+05	1.528E+06	19.6 ± 20.5
14	0	9	12	0.000	8.9	0.000E+00	8.333E+05	0.0 ± 0.0
	5	96			9.6	4.669E+04	8.964E+05	

Area of basic unit = .0000009 cm-2

Chi Squared = 7.516 with 13 degrees of freedom
P(chi squared) = 87.4 %
Correlation Coefficient = 0.618
Variance of SQR(Ns) = 0.28
Variance of SQR(Ni) = 0.42

Ns/Ni = 0.052 ± 0.024
Mean Ratio = 0.052 ± 0.024

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass
Rho D = 1.225E+06cm-2; ND = 2756

POOLED AGE = 11.2 ± 5.2 Ma
MEAN AGE = 8.4 ± 3.8 Ma

89 POS 15A 13,000' - THOMPSON SS.

IRRADIATION LU059 SLIDE NUMBER 14
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	1	11	10	0.091	13.1	1.111E+05	1.222E+06	19.6 ± 20.5
2	2	3	16	0.667	2.2	1.389E+05	2.083E+05	142.4 ± 130.1
3	0	3	30	0.000	1.2	0.000E+00	1.111E+05	0.0 ± 0.0
4	1	5	15	0.200	4.0	7.407E+04	3.704E+05	43.1 ± 47.2
5	7	45	49	0.156	10.9	1.587E+05	1.020E+06	33.5 ± 13.6
6	11	20	30	0.550	7.9	4.074E+05	7.407E+05	117.7 ± 44.3
7	10	51	12	0.196	50.5	9.259E+05	4.722E+06	42.2 ± 14.6
8	0	5	35	0.000	1.7	0.000E+00	1.587E+05	0.0 ± 0.0
9	32	118	40	0.271	35.1	8.889E+05	3.278E+06	58.3 ± 11.7
10	1	7	20	0.143	4.2	5.556E+04	3.889E+05	30.8 ± 32.9
11	0	15	35	0.000	5.1	0.000E+00	4.762E+05	0.0 ± 0.0
12	3	5	10	0.600	5.9	3.333E+05	5.556E+05	128.3 ± 93.8
13	3	19	35	0.158	6.4	9.524E+04	6.032E+05	34.0 ± 21.2
14	1	3	20	0.333	1.8	5.556E+04	1.667E+05	71.6 ± 82.7
15	1	3	24	0.333	1.5	4.630E+04	1.389E+05	71.6 ± 82.7
16	0	3	25	0.000	1.4	0.000E+00	1.333E+05	0.0 ± 0.0
17	6	19	28	0.316	8.1	2.381E+05	7.540E+05	67.9 ± 31.8
18	5	25	18	0.200	16.5	3.086E+05	1.543E+06	43.1 ± 21.1
19	1	9	12	0.111	8.9	9.259E+04	8.333E+05	24.0 ± 25.3
20	9	32	16	0.281	23.8	6.250E+05	2.222E+06	60.5 ± 22.9
21	6	10	12	0.600	9.9	5.556E+05	9.259E+05	128.3 ± 66.3
22	2	27	30	0.074	10.7	7.407E+04	1.000E+06	16.0 ± 11.7
23	0	3	12	0.000	3.0	0.000E+00	2.778E+05	0.0 ± 0.0
24	0	4	15	0.000	3.2	0.000E+00	2.963E+05	0.0 ± 0.0
25	4	13	21	0.308	7.4	2.116E+05	6.878E+05	66.1 ± 37.8
26	38	122	24	0.311	60.4	1.759E+06	5.648E+06	66.9 ± 12.5
	144	580			11.6	2.694E+05	1.085E+06	

Area of basic unit = .0000009 cm-2

Chi Squared = 28.762 with 25 degrees of freedom
P(chi squared) = 27.4 %
Correlation Coefficient = 0.961
Variance of SQR(Ns) = 2.59
Variance of SQR(Ni) = 6.72

Ns/Ni = 0.248 ± 0.023
Mean Ratio = 0.241 ± 0.026

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass
Rho D = 1.225E+06cm-2; ND = 2756

POOLED AGE = 53.4 ± 5.1 Ma
MEAN AGE = 48.8 ± 8.6 Ma

89 POS 16A 11,450' - CANNING FM.

IRRADIATION LU060 SLIDE NUMBER 1
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	2	5	12	0.400	5.0	1.852E+05	4.630E+05	85.4 ± 71.4
2	7	89	42	0.079	25.3	1.852E+05	2.354E+06	16.9 ± 6.6
3	1	2	9	0.500	2.7	1.235E+05	2.469E+05	106.5 ± 130.5
4	34	107	18	0.318	71.0	2.099E+06	6.605E+06	67.9 ± 13.5
5	4	9	25	0.444	4.3	1.778E+05	4.000E+05	94.8 ± 57.0
6	1	13	6	0.077	25.9	1.852E+05	2.407E+06	16.5 ± 17.1
7	2	1	12	2.000	1.0	1.852E+05	9.259E+04	415.9 ± 509.4
8	1	6	30	0.167	2.4	3.704E+04	2.222E+05	35.7 ± 38.6
9	3	8	14	0.375	6.8	2.381E+05	6.349E+05	80.0 ± 54.2
10	1	2	9	0.500	2.7	1.235E+05	2.469E+05	106.5 ± 130.5
11	4	34	24	0.118	16.9	1.852E+05	1.574E+06	25.2 ± 13.3
12	2	6	12	0.333	6.0	1.852E+05	5.556E+05	71.2 ± 58.2
13	4	10	24	0.400	5.0	1.852E+05	4.630E+05	85.4 ± 50.5
14	13	34	42	0.382	9.7	3.439E+05	8.995E+05	81.6 ± 26.7
15	2	3	28	0.667	1.3	7.936E+04	1.190E+05	141.6 ± 129.3
16	2	6	25	0.333	2.9	8.889E+04	2.667E+05	71.2 ± 58.2
17	0	4	28	0.000	1.7	0.000E+00	1.587E+05	0.0 ± 0.0
18	0	17	16	0.000	12.7	0.000E+00	1.181E+06	0.0 ± 0.0
19	2	13	20	0.154	7.8	1.111E+05	7.222E+05	33.0 ± 25.0
20	2	5	12	0.400	5.0	1.852E+05	4.630E+05	85.4 ± 71.4
21	3	13	50	0.231	3.1	6.667E+04	2.889E+05	49.4 ± 31.6
22	31	42	48	0.738	10.5	7.176E+05	9.722E+05	156.6 ± 37.3
23	4	7	16	0.571	5.2	2.778E+05	4.861E+05	121.6 ± 76.3
24	7	61	40	0.115	18.2	1.944E+05	1.694E+06	24.6 ± 9.8
25	6	16	15	0.375	12.7	4.444E+05	1.185E+06	80.0 ± 38.4
	138	513			10.6	2.657E+05	9.879E+05	

Area of basic unit = .0000009 cm-2

Chi Squared = 57.627 with 24 degrees of freedom
P(chi squared) = 0.0 %
Correlation Coefficient = 0.722
Variance of SQR(Ns) = 1.89
Variance of SQR(Ni) = 6.11

Ns/Ni = 0.269 ± 0.026
Mean Ratio = 0.281 ± 0.046

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass
Rho D = 1.218E+06cm-2; ND = 2741

POOLED AGE = 57.5 ± 5.7 Ma
MEAN AGE = 82.6 ± 16.7 Ma

89 POS 17A 9,100' - CANNING FM.

IRRADIATION LU060 SLIDE NUMBER 2
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	6	15	15	0.400	12.0	4.444E+05	1.111E+06	85.4 ± 41.3
2	4	8	16	0.500	6.0	2.778E+05	5.556E+05	106.5 ± 65.3
3	3	14	10	0.214	16.7	3.333E+05	1.556E+06	45.9 ± 29.2
4	2	12	12	0.167	12.0	1.852E+05	1.111E+06	35.7 ± 27.3
5	0	5	18	0.000	3.3	0.000E+00	3.086E+05	0.0 ± 0.0
6	3	4	6	0.750	8.0	5.556E+05	7.407E+05	159.1 ± 121.6
7	8	20	24	0.400	10.0	3.704E+05	9.259E+05	85.4 ± 35.8
8	8	64	21	0.125	36.4	4.233E+05	3.386E+06	26.8 ± 10.1
9	3	7	15	0.429	5.6	2.222E+05	5.185E+05	91.4 ± 63.1
10	4	2	16	2.000	1.5	2.778E+05	1.389E+05	415.9 ± 360.3
11	4	9	12	0.444	9.0	3.704E+05	8.333E+05	94.8 ± 57.0
12	4	7	15	0.571	5.6	2.963E+05	5.185E+05	121.6 ± 76.3
13	7	82	20	0.085	49.0	3.889E+05	4.556E+06	18.3 ± 7.2
14	67	221	70	0.303	37.7	1.063E+06	3.508E+06	64.8 ± 9.2
15	15	21	18	0.714	13.9	9.259E+05	1.296E+06	151.6 ± 51.4
16	17	44	35	0.386	15.0	5.397E+05	1.397E+06	82.5 ± 23.6
17	10	15	18	0.667	10.0	6.173E+05	9.259E+05	141.6 ± 57.9
18	2	5	8	0.400	7.5	2.778E+05	6.944E+05	85.4 ± 71.4
19	52	69	40	0.754	20.6	1.444E+06	1.917E+06	159.9 ± 29.6
20	7	71	30	0.099	28.3	2.593E+05	2.630E+06	21.1 ± 8.4
	226	695			19.8	5.993E+05	1.843E+06	

Area of basic unit = .0000009 cm-2

Chi Squared = 74.470 with 19 degrees of freedom
P(chi squared) = 0.0 %
Correlation Coefficient = 0.830
Variance of SQR(Ns) = 3.65
Variance of SQR(Ni) = 11.15

Ns/Ni = 0.325 ± 0.025
Mean Ratio = 0.362 ± 0.059

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass
Rho D = 1.218E+06cm-2; ND = 2741

POOLED AGE = 69.5 ± 5.6 Ma
MEAN AGE = 100.3 ± 20.4 Ma

89 POS 19A 2,200' - SAGAVANIRKTOK FM.

IRRADIATION LU060 SLIDE NUMBER 4
COUNTED BY: POS

No.	Ns	Ni	Na	RATIO	U (ppm)	RHOs	RHOi	F.T. AGE (Ma)
1	113	287	70	0.394	49.0	1.794E+06	4.556E+06	84.0 ± 9.5
2	14	41	9	0.341	54.4	1.728E+06	5.062E+06	72.9 ± 22.6
3	0	6	36	0.000	2.0	0.000E+00	1.852E+05	0.0 ± 0.0
4	1	2	9	0.500	2.7	1.235E+05	2.469E+05	106.5 ± 130.5
5	11	19	4	0.579	56.8	3.056E+06	5.278E+06	123.2 ± 46.8
6	0	9	9	0.000	12.0	0.000E+00	1.111E+06	0.0 ± 0.0
7	0	4	4	0.000	12.0	0.000E+00	1.111E+06	0.0 ± 0.0
8	0	1	16	0.000	0.7	0.000E+00	6.944E+04	0.0 ± 0.0
9	4	4	4	1.000	12.0	1.111E+06	1.111E+06	211.3 ± 149.5
10	46	62	30	0.742	24.7	1.704E+06	2.296E+06	157.4 ± 30.9
11	1	1	9	1.000	1.3	1.235E+05	1.235E+05	211.3 ± 298.9
12	0	4	49	0.000	1.0	0.000E+00	9.070E+04	0.0 ± 0.0
	190	440			21.1	8.478E+05	1.963E+06	

Area of basic unit = .0000009 cm-2

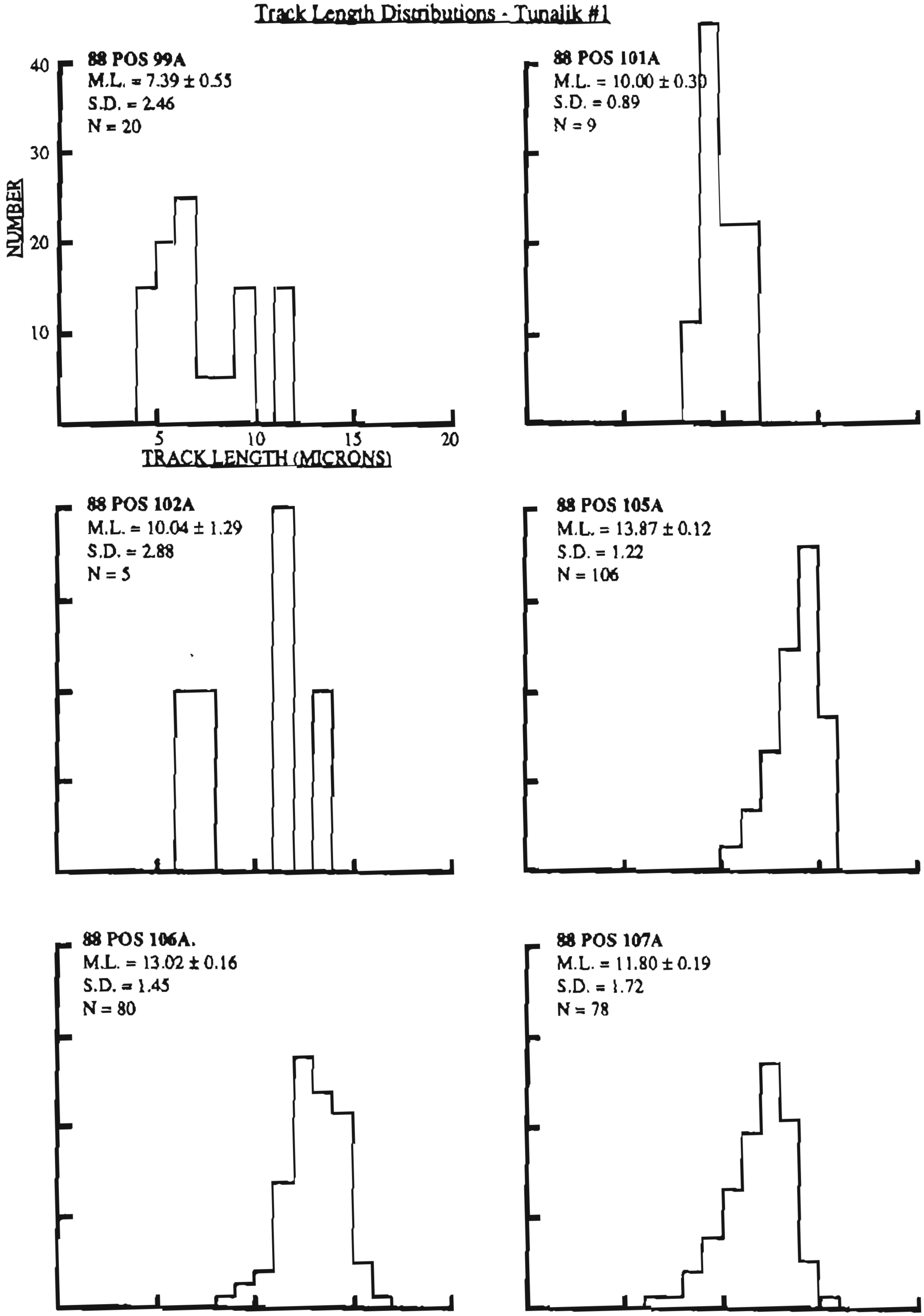
Chi Squared = 22.047 with 11 degrees of freedom
P(chi squared) = 2.4 %
Correlation Coefficient = 0.980
Variance of SQR(Ns) = 11.13
Variance of SQR(Ni) = 20.73

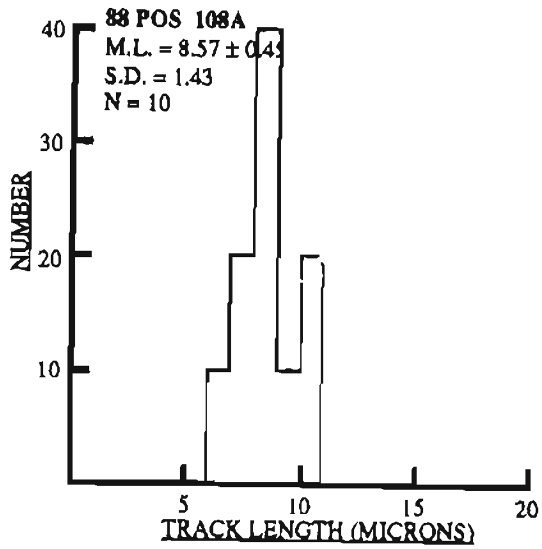
Ns/Ni = 0.432 ± 0.037
Mean Ratio = 0.401 ± 0.080

Ages calculated using a zeta of 352.7 ± 5 for SRM612 glass
Rho D = 1.218E+06cm-2; ND = 2741

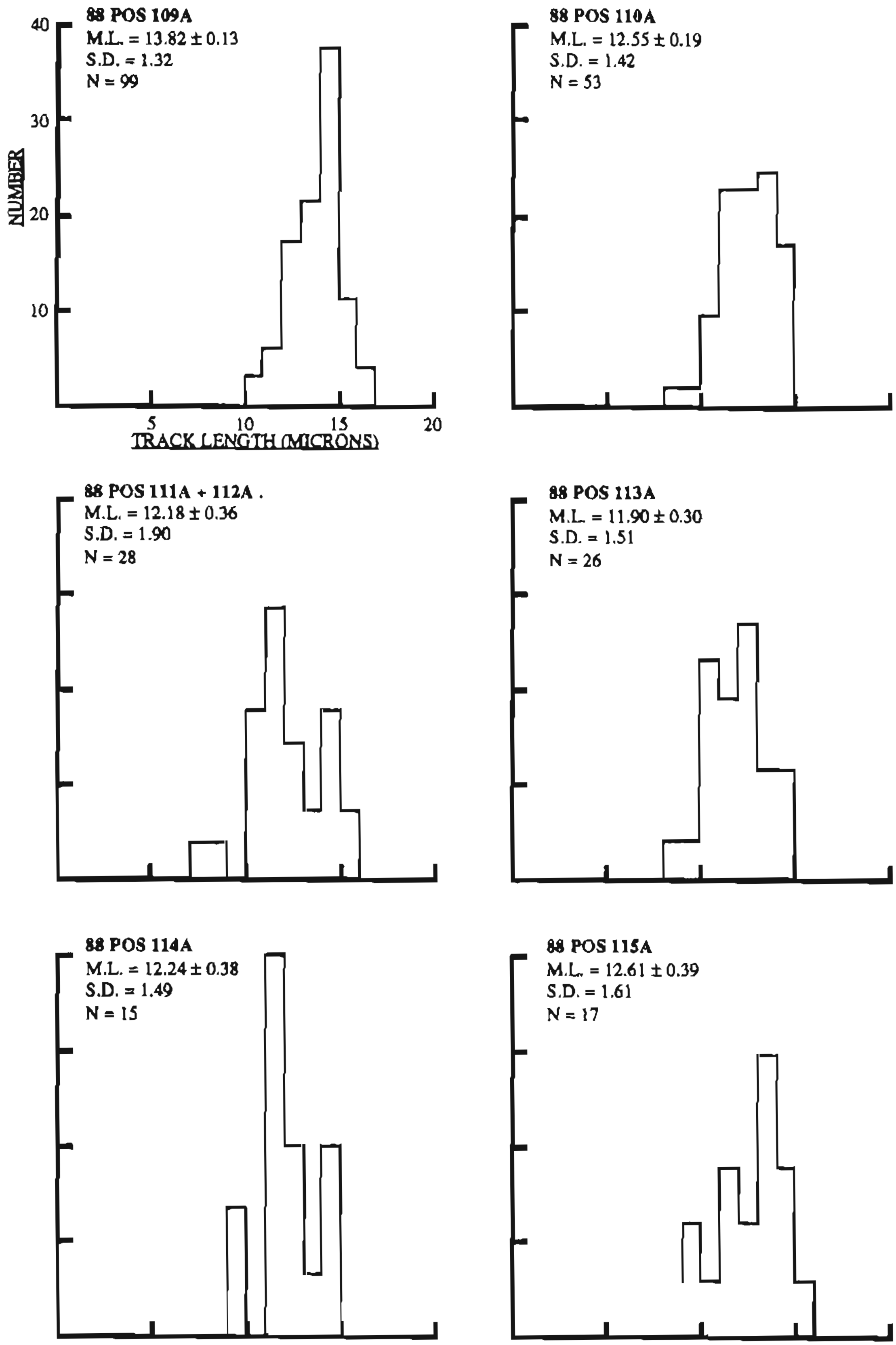
POOLED AGE = 92.1 ± 8.3 Ma
MEAN AGE = 81.0 ± 24.1 Ma

Track Length Distributions - Tunalik #1

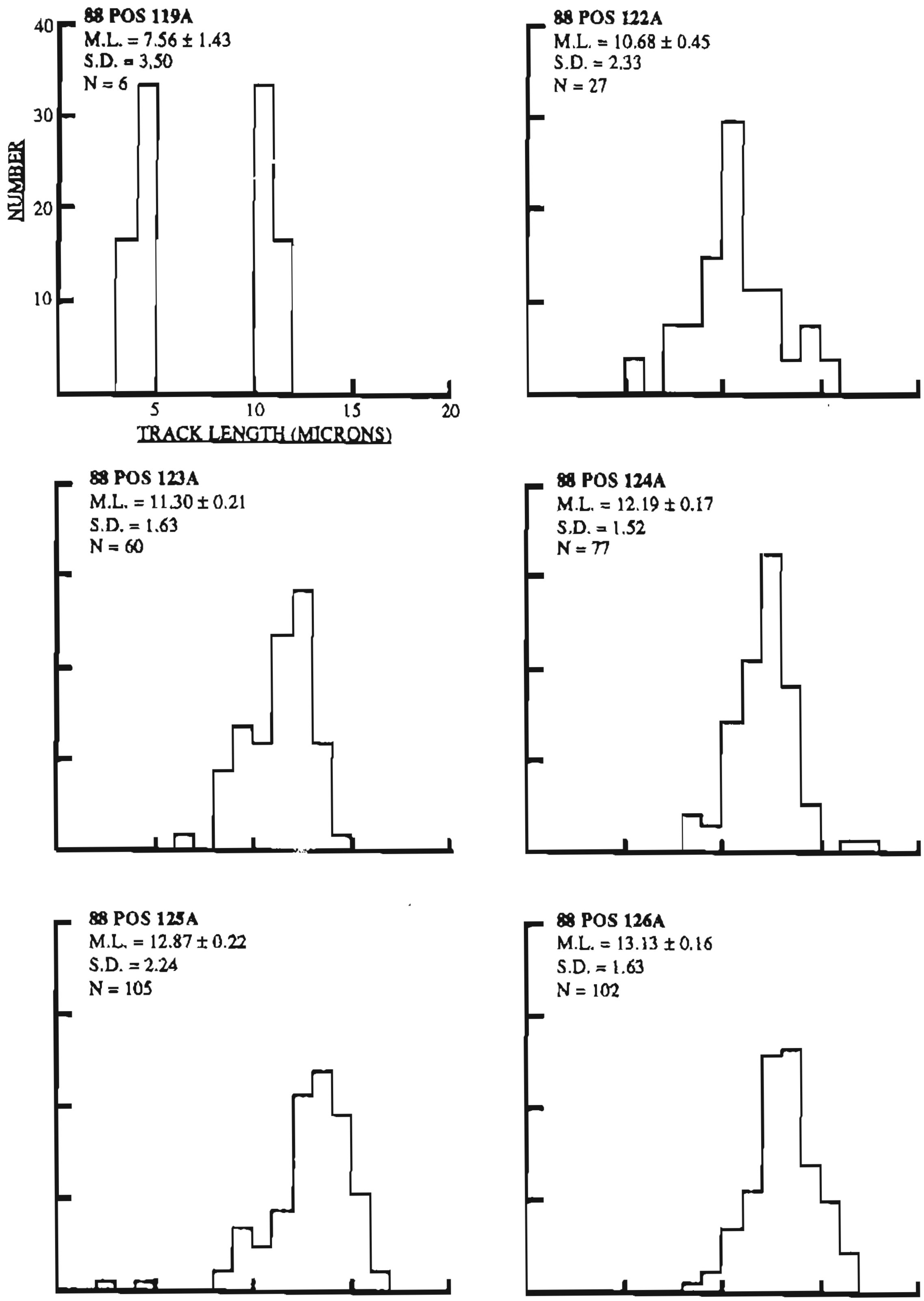


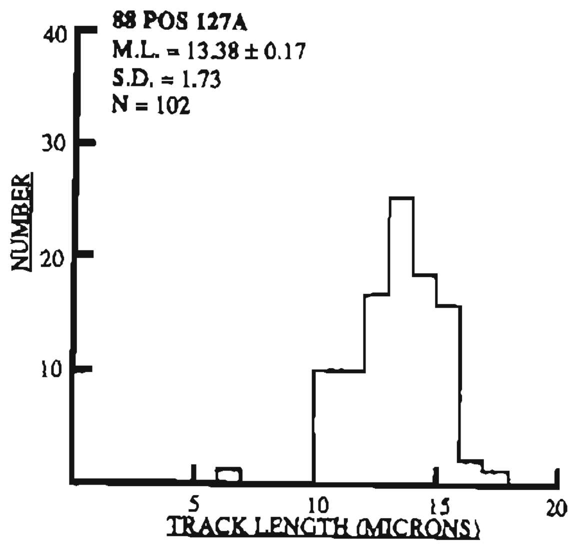

88 POS 108A
M.L. = 8.57 ± 0.45
S.D. = 1.43
N = 10
NUMBER
40
30
20
10
5
10
15
20
TRACK LENGTH (MICRONS)

Track Length Distributions - Walapka #1, #2

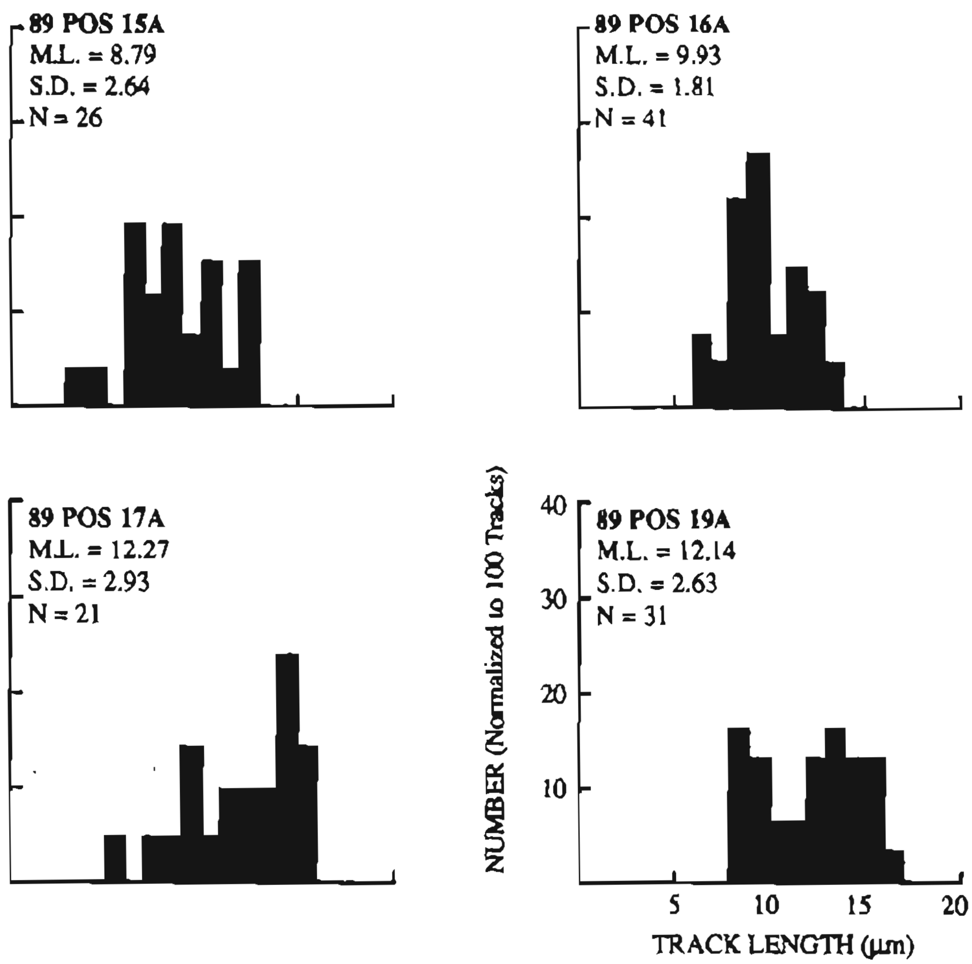


Track Length Distributions - Inigok #1




88 POS 127A
M.L. = 13.38 ± 0.17
S.D. = 1.73
N = 102
NUMBER
40
30
20
10
5
10
15
20
TRACK LENGTH (MICRONS)

Track Length Distributions- Alaska State C-1



REFERENCES

Bader, J.W. and Bird, K.J. (1986). Geologic map of the Demarcation, Mt. Michelson, Flaxman, and Barter quadrangles, northeastern Alaska. U.S. Geological Survey Miscellaneous Investigation Series I 1971.

Bayless, G.F. and Magoon, L.B. (1988). Organic facies and thermal maturity of sedimentary rocks in the National Petroleum Reserve in Alaska. In: Gryc, G., (ed.), Geology and Exploration of the National Petroleum Reserve in Alaska, 1974 to 1982. U. S. Geological Survey Professional Paper 1399: 489-518.

Bird, K.J. (1987). The framework geology of the north slope of Alaska as related to oil-source rock correlations. In: Tailleur, I.L. and Weimer, P., (eds.), Alaskan North Slope Geology. Society of Economic Paleontologists and Mineralogists Pacific Section Publication 50: 121-143.

Bird, K.J. and Molenaar, C.M. (1987). Stratigraphy. In: Bird, K.J. and Magoon, L.B., (eds.), Petroleum Geology of the Northern Part of the Arctic National Wildlife Refuge, Northeastern Alaska. U.S. Geological Survey Bulletin 1778: 37-59.

Blanchard, D.C. and Tailleur, I.L. (1982). Temperatures and intermal geothermal-gradient determinations from wells in National Petroleum Reserve in Alaska. U.S. Geological Survey Open-File Report 82-391: 79p.

Brosge, W.P. and Tailleur, I.L. (1970). Depositional history of northern Alaska. In: Adkison, W.L., and Brosge, M.M., (eds.), Proceedings of the geological seminar on the North Slope of Alaska. American Association of Petroleum Geologists Pacific Section Meeting, Los Angeles: D1-D18.

Brosge, W.P.,Reiser, H.N., Dutro, J.T. Jr., and Detterman, R.L. (1979). Bedrock geologic map of the Phillip Smith Mountains Quadrangle, Alaska. U.S. Geological Survey Miscellaneous Field Studies Map MF-879B, scale 1:250,000, 2 sheets.

Bruns, T.R., Fisher, M.A., Leinbach, W.J. and Miller, J.J. (1987). Regional structure of rocks beneath the coastal plain. In: Bird, K.J. and Magoon, L.B., (eds), Petroleum Geology of the Northern Part of the Arctic National Wildlife Refuge, Northeastern Alaska. U.S. Geological Survey Bulletin 1778: 249-254.

Detterman, R.L., Reiser, H.N., Brosge,W.P. and Dutro Jr., J.T., (1975). Post-Carboniferous Stratigraphy, Northeastern Alaska. U.S. Geological Survey Professional Paper 886: 46 p.

Dietrich, J.R., Dixon, J. and McNeil, D.H. (1985). Sequence analysis and nomenclature of Upper Cretaceous to Holocene strata in the Beaufort-Mackenzie Basin. In: Current Research, Part A, Geological Survey of Canada, paper 85-1A: 613-628.

Dillon, J.T., Tilton, G.R., Decker, J. and Kelly, M.J. (1987). Resource Implications of magmatic and metamorphic ages for Devonian igneous rocks in the Brooks Range. In: Tailleur, I.L. and Weimer, P., (eds.), Alaskan North Slope Geology. Society of Economic Paleontologists and Mineralogists Pacific Section Publication 50: 713-723.

Dodge, F.C.W. and Naeser , C.W., (1968). Ages of apatites from granitic rocks of the Sierra Nevada Batholith (abs). Transactions of the American Geophysical Union, v. 49: p. 348.

Duddy, I.R., Green, P.F. and Laslett, G.M. (1988). Thermal annealing in fission tracks 3: Variable temperature behaviour. Chemical Geology (Isotope Geoscience Section), 73: 25-38.

Fleischer, R.L., Price, P.B. and Walker, R.M. (1975). Nuclear tracks in solids: Principles and applications. University of California Press, Berkeley: 605 p.

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

Gleadow, A.J.W. and Duddy, I.R. (1981). A natural long term annealing experiment for apatite. Nuclear Tracks 5: 169-174.

Gleadow, A.J.W. and Duddy, I.R. (1984). Fission track dating and thermal history analysis of apatites from wells in the north-west Canning Basin. In: Purcell, P.G. (ed.), The Canning Basin, W. A., Proceedings of the Geological Society of Australia and Petroleum Exploration Society of Australia Symposium, Perth, 1984: 377-387.

Gleadow, A.J.W. and Fitzgerald, P.G. (1984). Uplift history of the Transantarctic Mountains in the Dry Valleys area, southern Victoria Land, Antarctica, from apatite fission track ages. New Zealand Journal of Geology and Geophysics, v. 27: 457-464.

Gleadow, A.J.W. and Fitzgerald, P.G. (1987). Uplift history and structure of the Transantarctic Mountains: new evidence from fission track dating of basement apatites in the Dry Valleys area, southern Victoria Land. Earth and Planetary Science Letters, v. 82: 1-14.

Gleadow, A.J.W., Duddy, I.R. and Lovering, J.F. (1983). Fission track analysis: a new tool for the evaluation of thermal histories and hydrocarbon potential. Petroleum Exploration Association of Australia Journal 23: 93-102.

Gleadow, A.J.W., Duddy, I.R., Green, P.F. and Hegarty, K.A. (1986a). Fission track lengths in the apatite annealing zone and the interpretation of mixed ages. Earth and Planetary Science Letters, v. 78: 245-254.

Gleadow, A.J.W., Duddy, I.R., Green, P.F. and Lovering J.F. (1986b). Confined fission track lengths in apatite: a diagnostic tool for thermal history analysis. Contributions to Mineral Petrology, v. 94: 405-415.

Grantz, A. and May, S.D. (1983). Rifting history and structural development of the continental margin north of Alaska. In: Watkins, J.S. and Drake, C.L. (eds.), Studies in continental margin geology. American Association of Petroleum Geologists Memoir 34: 77-100.

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

Green, P.F. (1985). Comparison of zeta calibration baselines for fission-track dating of apatite, zircon and sphene. Chemical Geology, v. 58: 1-22.

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 Geological Society of London. (in press).

Green, P.F., Duddy, I.R., Gleadow, A.J.W., Tingate, P.T. and Laslett, G.M. (1985). Fission-track annealing in apatite: track length measurements and the form of the Arrhenius plot. Nuclear Tracks 10: 323-328.

Green, P.F., Duddy, I.R., Gleadow, A.J.W., Tingate, P.T. and Laslett, G.M. (1986). Thermal annealing of fission tracks in apatite: 1 - a qualitative description. Isotope Geoscience, v. 59: 237-253.

Green, P.F., Duddy, I.R., Gleadow, A.J.W. and Lovering, J.F. (1989a). Apatite fission track analysis as a paleotemperature indicator for hydrocarbon exploration. In: Naeser, N.D. (ed.), Thermal History of Sedimentary Basins-Methods and Case Histories. Springer-Verlag, New York: 181-195.

Green, P.F., Duddy, I.R., Laslett, G.M., Hegarty, K.A., Gleadow, A.J.W., and Lovering, J.F. (1989b). 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.

Harrison, T.M., Armstrong, R.L., Naeser, C.W. and Harakal, J.E. (1979). Geochronology and thermal history of the Coast Plutonic Complex, near Prince Rupert, British Columbia. Canadian Journal of Earth Sciences, v. 16: 400-410.

Hubbard, R.J., Edrich, S.P. and Rattey, R.P. (1987). Geologic evolution and hydrocarbon habitat of the 'Arctic Alaska Microplate. In: Tailleur, I.L. and Weimer, P., (eds.), Alaskan North Slope Geology. Society of Economic Paleontologists and Mineralogists Pacific Section Publication 50: 797-830.

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.

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.

Laslett, G.M., Green, P.F., Duddy, I.R. and Gleadow, A.J.W. (1987). Thermal modelling of fission tracks in apatite: 2. A quantitative analysis. Chemical Geology, v. 65: 1-13.

Lerand, Monti (1973). Beaufort Sea. In: McCrossan, R.G. (ed.), The Future Petroleum Provinces of Canada--Their Geology and Potential. Canadian Society Petroleum Geologists Memoir 1: 315-386.

Naeser, C.W. (1979). Fission track dating and geologic annealing of fission tracks. In: Jager, E. and Hunziker, J.C. (eds.), Lectures in Isotope Geology. Springer Verlag, New York: 154-169.

Naeser, C.W., Bryant, B., Crittenden, M.D. and Sorensen, M.L. (1983). Fission-track ages of apatite in the Wasatch Mountains, Utah: An uplift study. Geological Society of America Memoir 157: 29-36.

Oldow, J.S., Seidensticker, C.M., Phelps, J.C., Julian, F.E., Gottschalk, R.R., Boler, K.W.,Handschy, J.W. and Ave Lallement, H.G. (1987). Balanced cross sections through the central Brooks Range and North Slope, Arctic Alaska. American Association of Petroleum Geologists Publication: 19 p., 8 plates.

O'Sullivan, P.B. (1988). Apatite fission track study of the thermal history of Permian to Tertiary sedimentary rocks in the Arctic National Wildlife Refuge, northeastern Alaska. Alaska Division of Geological and Geophysical Surveys Public Data File 88-42: 142 p.

O'Sullivan, P.B. (1989a). Preliminary Results of 14 Apatite Fission Track Analyses of Samples From The Umiat and Colville River Region, North Slope Alaska. Alaska Division of Geological and Geophysical Surveys Public Data File 89-2E: 21 p.

O'Sullivan, P.B. (1989b). Preliminary results of 13 apatite fission analyses from the Slope Mountain and Sagavanirktok River region, North Slope, Alaska: Alaska Geological and Geophysical Surveys Public Data File 89-2c, 20 p.

O'Sullivan, P.B. (1989c). Preliminary results of 24 apatite fission analyses from four wells in the National Petroleum Reserve in Alaska: Alaska Geological and Geophysical Surveys Public Data File 89-2a, 32 p.

O'Sullivan, P.B. (1990a). Preliminary results of 11 apatite fission analyses from the Galbraith Lake- Toolik Lake region, North Slope, Alaska: Alaska Geological and Geophysical Surveys Public Data File 90-7a, 17 p.

O'Sullivan, P.B., Decker, J.E., and Bergman, S.C. (1989). Apatite fission-track study of the thermal history of Permian to Tertiary sedimentary rocks in the Arctic National Wildlife Refuge, northeastern Alaska. Geological Society of America Abstracts with Programs, v. 21, no. 5, p. 126.

O'Sullivan, P.B., Decker, J., Bergman, S.C. and Wallace, W.K. (1990a). Constraints by apatite fission track analysis on the cooling times due to uplift of the northeastern Brooks Range, Alaska (abs.): American Association of Petroleum Geologists Bulletin. v. 74. p. 733.

O'Sullivan, P.B., Decker, J., Bergman, S.C. and Wallace, W.K. (1990b). Apatite fission track evidence for Tertiary uplift in the northeastern Brooks Range, Alaska (abs.): *in* Abstracts Volume, Seventh International Conference on Geochronolgy, Cosmochronology and Isotope Geology.

O'Sullivan, P.B., Green, P.F., Decker, J.E., Duddy, I.R., Bergman, S.C., and Turner, D.L. Paleocene to Miocene deformation in the northeastern Brooks Range, Alaska, by Apatite Fission Track Analysis: (in prep)

Palmer, I.F., Bolmm, J.R., Maxey, L.R. and Lyle, W.M. (1979). Petroleum source rock and reservoir quality data from outcrop samples, onshore North Slope of Alaska east of Prudhoe Bay. U.S. Geological Survey Open-File Report 79-1634: 14 plates, 52 p.

Rattey, R.P. (1987). Northeastern Brooks Range, Alaska--new evidence for complex thin-skinned thrusting (abs). In: Taiileur, I.L. and Weimer, P., (eds.), Alaskan North Slope Geology. Society of Economic Paleontologists and Mineralogists Pacific Section Publication 50: p.757.

Sable, E.G. (1977). Geology of the western Romanazof Mountains, Brooks Range, northeastern Alaska. U.S. Geological Survey Professional Paper 897: 84 p.

Sieber, K.G. (1986). Compositional variation in apatites. B.Sc (Honors) thesis, University of Melbourne: 85 p.

Wagner, G.A. and Storzer, D. (1972). Fission track length reductions in minerals and the thermal history of rocks. Trans. Am. Nucl. Soc. 15: 127-128.

Wagner, G.A., Reimer, G.M. and Jager, E. (1977). The cooling ages derived by apatite fission track, mica Rb-Sr, and K-Ar dating: the uplift and cooling history of the central Alps. Inst. Geol. Mineral., Univ. Padova, Italy, Mem. 30: 27 p.

Wallace, W.K. and Hanks, C.L. (1988a). Stratigraphic controls on lateral variations in the structural style of the northeastern Brooks Range, Arctic National Wildlife Refuge (ANWR), Alaska. American Association of Petroleum Geologists Bulletin, v. 72/2: p. 256.

Wallace, W.K. and Hanks, C.L. (1988b). Lateral variations in the range-front structure of the northeastern Brooks Range, Arctic National Wildlife Refuge (ANWR), Alaska. Geological society of America, Cordillera Section Abstracts with Programs. v. 20/3: p. 241.

Wallace, W.K. and Hanks, C.L. (1990). Structural provinces of the northeastern Brooks Range, Arctic National Wildlife Refuge, Alaska. American Association of Petroleum Geologists Bulletin, v. 74/7: 1100-1118.

Zeitler, P.K. (1985). Cooling history of the NW Himalaya, Pakistan. Tectonics, 4, 127-151.

Zeitler, P.K., Tahirkhell, R.A.K., Naeser, C.W. and Johnson, N.M. (1982). Unroofing history of a suture zone in the Himalaya of Pakistan by means of fission track annealing ages. Earth and Planetary Science Letters, v. 57: 227-240.