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Tyler M. Izykowski
Union College - Schenectady, NY

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Detrital zircon fission track ages of the Paleocene Orca Group of Eastern Prince William Sound, near Cordova, Alaska

by

Tyler Michael Izykowski

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Submitted in partial fulfillment
of the requirements for the degree of
Bachelor of Science Department of Geology

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ABSTRACT

IZYKOWSKI, TYLER MICHAEL. Detrital zircon fission track ages of the Paleocene Orca Group of Eastern Prince William Sound, near Cordova, Alaska. Department of Geology, Union College, Schenectady, New York, June 2011.

The Prince William terrane is a major component of the Mesozoic-Tertiary accretionary complex of the North American Cordillera that is well exposed for ~2200 km in southern Alaska and is inferred to be one of the thickest accretionary complexes in the world. Detrital zircons from Prince William terrane record the thermal evolution and exhumation history of the accretionary wedge. Samples of the Paleocene-Eocene Orca Group of the Prince William terrane were analyzed using detrital zircon fission track techniques to understand the thermochronology of the region near Cordova. Six sandstones from the Orca Group and one sample of the Sheep Bay Granite were collected, dated, and track lengths were analyzed. In the Orca Group, the six samples collected along a transect from Sheep Bay to Cordova have a common cooling age of ~49 Ma, as well as older populations at ~79 Ma and older. Samples collected to the east of the NE-SW-trending Rude River fault have a young cooling age population at ~31 Ma that is essentially absent to the west of the fault. The ~52 Ma Sheep Bay granite has a majority ZFT cooling age population that is overdispersed with grains at ~40 Ma and at ~28 Ma. Ages and track-length distributions vary on either side of the Rude River fault. To the east of the Rude River fault, in the Orca Group, track lengths are long and unimodal, suggesting full resetting of grains. To the west of the Rude River fault, track lengths are bimodal with an abundance of shortened tracks, indicating a significant degree of partial annealing. A similar and contemporaneous study found that the Valdez Group of the Chugach terrane to the north has a majority cooling age population at ~38 Ma, as well as a minority population at ~51 Ma that is evident in half of the samples studied. The Orca Group and the Valdez Group share a memory of cooling at c. 50 Ma that is likely related to an increase in the geothermal gradient of the region related to granitic intrusions of the Sanak-Baranof belt driven by passage of the slab window and appears to lag that event by only several Myr. The young cooling ages record a landward age progession for the exhumation of the orogenic wedge in the Late Eocene (~38 to 32 Ma).

DEDICATION

This thesis is dedicated to my mother, Denise, and my father, Thomas, who have given me every opportunity in life to succeed. Without their unwavering support and encouragement throughout my life, none of this would have been possible.

ACKNOWLEDGEMENTS

I would like to sincerely thank everyone who helped make this project possible and run smoothly. I would especially like to thank the people and organizations that provided facilities and funding available along the way, in particular, Dr. Lee L. Davenport for funding Union College summer research, the Oregon State University nuclear reactor, Cordova Coastal Outfitters, the Union College Geology Department, and the Union College Fission Track Lab. A portion of the field and laboratory expenses was provided by the American Chemical Society – Petroleum Research Fund (ACS PRF 47191-AC8 to Garver). The Scanning Electron Microscope was supported by the National Science Foundation (NSF EAR 0619578 MRI: Acquisition of a Variable Pressure Scanning Electron Microscope to Traver, Garver, and others). The Micro-Raman Spectroscopy was supported by the National Science Foundation (NSF DMR 0959272 MRI-R2: Acquisition of Micro-Raman and Micro-IR Spectrometers for a Multi-disciplinary Spectroscopy Laboratory at Union College to Hayes, Garver, and others). I would like to thank Professors Jaclyn Cockburn and John Garver and the "Living on the Edge: Alaska" program for opening the door to the splendor that exists in The Great Land.

The following individuals provided invaluable support and assistance along the way: Deborah Klein, for making arrangements both in Alaska and within the department; Bill Neubeck, for keeping the Union College Fission Track running smoothly and fixing the countless messes I found myself in; the 2009 and 2010 Living on the Edge groups, for helping me discover Alaska; Colleen Kennedy '12 and Michael Sachs '13, for assistance in the field; and Leonard D. Ancuta '10, for advice and guidance in completing this project. I would like to also thank my ever-present brother-in-arms, Edward Milde, for helping to discover and understand the world of fission tracks. Finally, I would like to thank Professor John Garver for sharing his knowledge, especially that of Alaskan geology, and introducing me to the field of thermochronology. Without his hard work and dedication to this project, it could not have been successful.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The southern margin of Alaska is comprised of a complex assemblage of terranes. The margin is an active subduction zone with and active volcanic arc, a significant strike-slip fault system, and the ongoing collision of the Yakutat block (Ridgeway and Flesch, 2007). The several thousand kilometer long margin is composed of numerous accreted terranes, the largest and most significant of which are the Peninsular terrane, the Wrangellia terrane, and the Alexander terrane (Figure 1). Together these terranes make up what is known as the Insular Superterrane, which comprises the continental framework of southern and southeastern Alaska. Many of the terranes in this region are separated by strike-slip faulting that is primarily dextral in nature, such as the Border Ranges fault.

Outboard of the continental framework defined by the Insular Superterrane are the later-accreted Chugach and Prince William terranes, often referred to as the Chugach-Prince William (CPW) composite terrane, which is a 2200 km sequence of sandstone, mudstone, volcanics and flysch (Cowan, 2003). The Paleocene Orca Group of the Prince William terrane is a very thick sequence of turbiditic and volcanic rocks in the Prince William Sound area (Plafker et al., 1985; Kveton, 1989). It has been metamorphosed to at least prehnite-pumpellyite grade and up to lower greenschist and amphibolite grade throughout the belt with only minor exceptions (Plafker et al., 1985; Winkler, 1976).

The tectonic activity of the rocks that make up the southern margin has been active since the Cretaceous and though there is some debate regarding its evolution, it has been the focus of many studies (Cowan, 2003; Haeussler et al., 2003; Madsen, 2006; Ridgeway and Flesch, 2007). One important aspect of this belt is the Sanak-Baranof intrusive belt, which is a swath of plutons, varying in composition from granite to gabbro to granodiorite that intruded the CPW terrane in the Paleocene to Eocene (Plafker, 1987; Plafker et al., 1994; Bradley et al., 2003). The intrusive belt is unusual because these are near-trench plutons that are the product of the subduction of at least one trench-ridge-trench triple junction, allowing for the intrusion of plutons as the slab window passed into

the asthenosphere (Bradley et al., 2003; Cowan, 2003; Haeussler et al., 2003). There is a west-to-east age progression along the belt from 61 Ma in the west to 50 Ma in the east (Bradley et al., 2003). In one hypothesis, the Sanak-Baranof belt is the result of the Kula-Farallon spreading ridge subducting trench-parallel in the east and obliquely (30°) in the west (Bradley et al., 2003; Cowan, 2003). Alternative hypotheses suggest additional theoretical plates (now subducted) to explain the Sanak-Baranof belt, such as the "Resurrection Plate" of Haeussler et al. (2003) and the "Eshamy Plate" of Madsen et al. (2006). The single-ridge hypothesis requires the transport of terranes from the south upwards of at least 1100 km along the North American Margin, whereas the dual-ridge hypotheses require the end-members of the Sanak-Baranof belt to have been formed in place (Cowan, 2003; Haeussler et al., 2003; Madsen et al., 2006).

Detrital thermochronology is a tool that has been widely used to help understand tectonic evolution in geologic settings all over the world (Bernet and Garver, 2005). In the southern margin of Alaska, numerous studies have employed thermochronology techniques to reconstruct the time-temperature histories of rock sequences, including U-Pb, K-Ar, vitrinite reflectance, and apatite and zircon fission track dating (Clendenen et al., 2003; Gasser, 2010; Kveton, 1989; Milde, 2011; Nelson et al., 1999; Sample and Moore, 1987; Sample and Reid, 2003; Enklemann et al., 2009). The Orca Group of the Prince William terrane has been studied in the past by Kveton (1989) in western Prince William Sound, however little has been done on the Orca Group on the east of the Sound, near Cordova.

By determining the low-temperature thermochronology of these rocks, a great deal of insight can be gained regarding the tectonic evolution of this region, which would have implications in the southern margin of Alaska. The present study aims to further our understanding of this complex region by performing detrital zircon fission track analysis on the sandstones of the Orca Group and the Sheep Bay Pluton in eastern Prince William Sound. A secondary goal of this study is to explore the heterogeneity of the annealing process in zircon. Track length and etch figure measurements, as well as Raman spectroscopy were performed to gain a better understanding of why certain zircon grains

anneal differently when exposed to similar thermal events. This thesis outlines the geology of the southern margin of Alaska, explains the methodologies employed, and provides and interprets the data in terms of its regional significance.

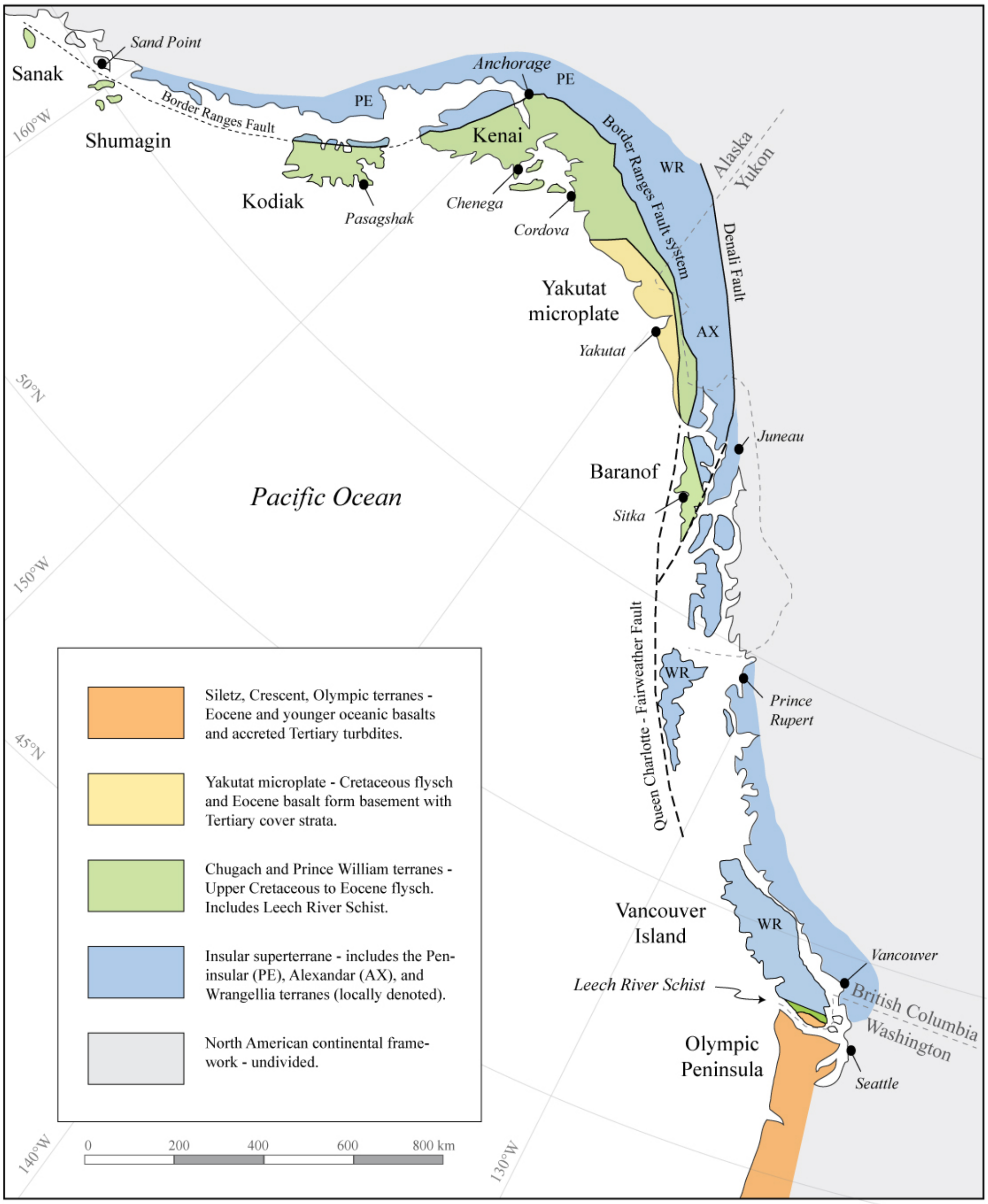

Figure 1. Map of terranes and faults in Alaska.

The Chugach terrane in Southeast Alaska

The Chugach-Prince William (CPW) terrane in Alaska (Figures 1, 2) is comprised of the inboard Chugach terrane (largely Cretaceous) and the outboard Prince William terrane (Upper Cretaceous-Paleocene), which are bound by the inland Border Ranges fault (Plafker et al., 1994). The boundary between the Chugach and Prince William terranes, really only exposed in the area around Prince William Sound is the Contact Fault, which is inferred to lie between the Upper Cretaceous Valdez Group and the Paleocene to Eocene Orca Group (Plafker, 1987). Outboard of the CPW terrane lie two primary elements: the modern subduction complex of the Alaskan margin, which is mainly under the shelf; and the Yakutat terrane, which is currently colliding with the Chugach in southern Alaska (see Enklemann et al., 2009; Perry et al., 2009). The Chugach-Prince William terrane followed Wrangellia in its north translation along the west coast of North America from the Late Triassic to Late Cretaceous (Plafker et al., 1994) when it detached from Wrangellia and continued on its northward path (Cowan, 2003). After this translation, the Yakutat terrane collided and dramatically affected the margin in the Late Tertiary (see Perry et al., 2009).

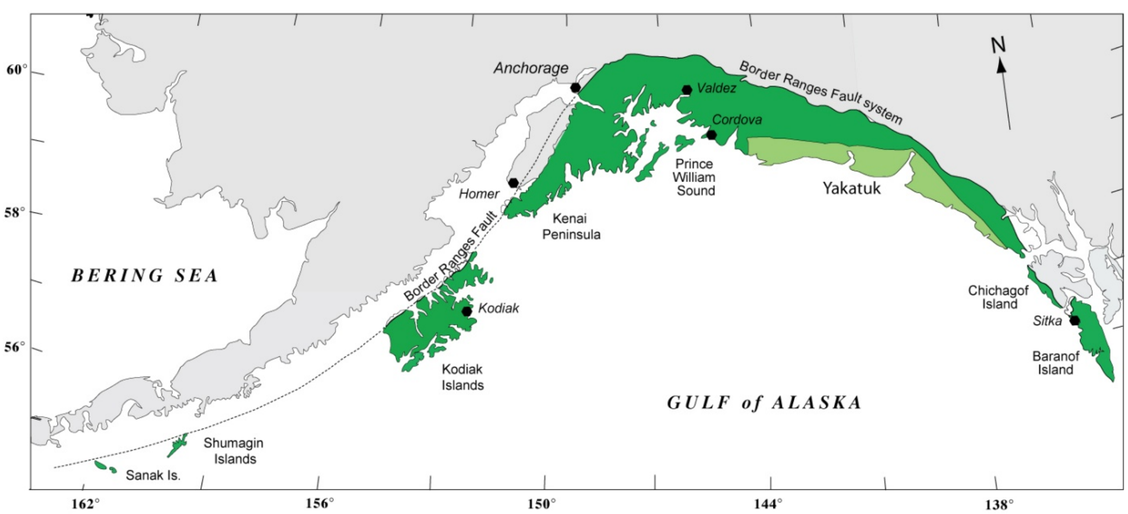

Figure 2. The Chugach-Prince William composite terrane of the southern margin of Alaska.

Chugach-Prince William terrane. The CPW terrane is a largely turbiditic, forearc accretionary complex that consists of sandstone, mudstone, volcanic, chert deposited in

the Cretaceous to early Tertiary (Cowan, 2003). It includes three basic elements: 1) inboard mesomélange between the Border Ranges Fault and the Eagle River Thrust; 2) the main thick belt of Upper Cretaceous turbiditic rocks; and 3) mélange and turbidites outboard of the Contact Fault (and its equivalents). The inboard mesomélange consists of a number of Mesozoic units that include the McHugh complex, Raspberry Schist, and Uyak Complex on Kodiak Island. In Seldovia (near Homer on the Kenai Peninsula) it contains the Seldovia Schist, the McHugh Complex, and minor ultra mafic rocks. In the Turnagain Arm (Anchorage) area it contains only the Cretaceous McHugh Complex (Amato and Pavlis, 2010). Around Chitina (northeast of Valdez), the mesomélange contains blueschist of Liberty Creek and also the McHugh Complex. There are also correlative rocks in the southeast on Baranof Island including the Kelp Bay Group.

The main part of the Chugach terrane consists of a very thick turbiditic unit with minor volcanics. The formations that make up this belt are similar in lithology and are (from east to west) the Shumagin Formation, Kodiak Formation, Valdez Group, and Sitka Graywacke, which are all stratigraphically equivalent and all are inferred to be Campanian-Maastrichtian in age but these age assignments are based on limited fossils (Bradley et al., 2003). South of the Contact Fault is the more outboard Prince William terrane, which is dominated by volcanic and quartzofeldspathic flysch that is dominantly Paleocene in age (Cowan, 2003). The Prince William terrane includes the Orca Group and may or may not include the Ghost Rocks, exposed on Kodiak Island. The Ghost Rocks have a paleomagnetic signature indicating their deposition occurred at least 1100 km south of their present location (Plumley et al., 1983).

The main part of the Chugach terrane represents turbidites deposited on a submarine fan that was then accreted to the continental margin. The Kodiak Formation is representative of the stratigraphic elements of the Chugach terrane and it is well studied (Sample and Reid, 2003). It was deposited as turbidites on a very large regionally extensive submarine fan (Sample and Reid, 2003). The Bengal Fan and Amazon Cone are comparable in that they are two of the largest submarine fans in the world, and the Zodiac Fan is considered a modern analog for the Chugach flysch in that it covers and large area

in the northeast Pacific and it is on a path to eventually accrete at the Aleutian Trench (Stevenson et al., 1983). In comparison to the passive margin Bengal Fan and Amazon Cone, as well as the active margin Zodiac Fan, it is evident that the Kodiak Formation is a very large mass of rapidly deposited sediment (Sample and Reid, 2003). The rapid deposition could be attributed to input from a highly active volcanic arc or extensive uplift of a volcanic-plutonic complex along the margin (Sample and Reid, 2003).

Post-depositional history

Intrusion of the Sanak-Baranof plutonic belt. In the Paleocene, the CPW terrane was intruded by granite plutons and locally metamorphosed to amphibolite grade (Plafker, 1987; Plafker et al., 1994). The Sanak-Baranof belt consists of granodiorite, granite, tonalite, and gabbro plutons and basaltic and rhyolitic dikes (Bradley et al., 2003). It is widely suggested that the intrusion of granitic rocks was the result of near-trench plutonism that was diachronous across the belt (i.e. Bradley et al., 2003). As subduction of a spreading-center progressed, dikes and plutons intruded the Chugach terrane between 65 and 50 Ma, forming the 2200 km long Sanak-Baranof plutonic belt (Plafker et al., 1994; Bradley et al., 2003; Cowan, 2003). The near-trench magmatism of the belt began at ~61 Ma at Sanak Island in the west, and ended at ~50-51 Ma at Baranof Island in the east (Bradley et al., 2003), resulting in a west-to-east age progression that is inferred to represent migration of a trench-ridge-trench triple junction (Bradley et al., 2003). The subduction of the spreading ridge is segmented and shifts from trench-parallel in the east to oblique (30°) to the west, that may have resulted in varying degrees of metamorphism with a higher apparent regional metamorphic grade to the east (Farris and Paterson, 2002).

Terrane translation. The CPW terrane and Sanak-Baranof belt are inferred to have experienced northward translation of at least 1100 km and this inference is based on fossil evidence, paleomagnetic data, and other geologic evidence (see Cowan, 2003). The Baranof-Leech River hypothesis of Cowan (2003) suggests that schists on southern Baranof Island were contiguous with the Leech River Complex on southern Vancouver Island at 50 Ma based on physical and petrogenic similarities (Cowan, 2003). Both units

are twice-deformed biotitic schist and phyllite derived from sandstone-mudstone flysch with similar mineral assemblages and K-Ar cooling ages of approximately 45-35 Ma (Cowan, 2003).

Using the present position of North America as a point of reference, the schists of Baranof Island and the Leech River complex were contiguous units of the 2200 km Chugach terrane at 50 Ma and were situated at approximately the present latitude of the Strait of Juan de Fuca (i.e. ~45°N, see Cowan, 2003). After 50 Ma (the last time of intrusion), the rocks on the southern tip of Baranof Island, along with the rest of the Chugach terrane, were displaced 1100 km north by coast-parallel slip along the Queen Charlotte-Fairweather fault system and their older equivalents (Cowan, 2003). The Queen Charlotte-Fairweather fault system eventually becomes the Border Ranges fault system to the north, which is the inboard bounding fault to the Chugach terrane.

Yakutat Collision. The Yakutat terrane is currently colliding with the SE margin of Alaska, into the Prince William terrane. The Yakutat terrane is made up of a basement of two primary elements: 1) early Tertiary basaltic rocks; and 2) Mesozoic mélange and flysch intruded by Tertiary near-trench plutons, and this latter basement unit appears to be identical to the Chugach terrane (Plafker et al. 1994). The Yakutat terrane is inferred to represent the former southeastern continuation of the Sanak-Baranof belt, which has since been detached and has undergone margin-parallel dextral displacement (Plafker et al., 1994; Bradley et al., 2003).

There are two hypotheses for the transport of the Yakutat terrane, both of which end in the collision of the Yakutat with the Chugach-Prince William composite terrane from the Pliocene to present (Perry et al., 2009). The long-transport hypothesis proposes that the basement rocks of the Yakutat originated off of northern California to Washington and have since experienced ~2000 km of continuous displacement starting ~45 Ma to its present-day collision zone with the Chugach-Prince William terrane (Bruns, 1983). The more conservative short-transport hypothesis suggests that the Yakutat terrane has a

much higher latitude origin and has migrated ~600 km north from the Late Eocene to present (Plafker et al., 1994; Perry et al., 2009).

Orca Group. The Paleocene Orca Group is an assemblage of several fault-bounded belts of rock, including sparsely fossiliferous quartzofeldspathic sandstone and mudstone submarine fans, and local mafic intrusive and volcanic rocks (Kveton, 1989). The Orca Group is bound by Upper Cretaceous volcaniclastic turbidites of the Valdez Group in the hanging-wall of the Contact Fault system to the north and west and the active eastern Aleutian subduction zone to the south (Kveton, 1989). The Orca and Valdez Groups are dominated by seaward-verging folds and thrust faults, characteristic of the Late Cretaceous to Paleocene accretionary complex of the Sanak-Baranof belt (Kveton, 1989). The Orca Group in the Cordova area was selected for study because these rocks represent an important part of the belt that is immediately west of the Yakutat collisional belt, and very little is known of their history in this area.

Single- versus Dual-ridge Hypotheses

There has been significant debate over the nature of the near-trench magmatism along the Mesozoic-early Tertiary accretionary complex in southern Alaska and from southern Baranof Island and also at the southern end of Vancouver Island and Washington State. There are two leading hypotheses, both of which require the subduction of at least one spreading center at a trench-ridge-trench (TRT) triple junction, that are used to explain the geologic data from terranes along the North American Margin. The geologic evidence include: (1) the time-transgressive plutonism of the Sanak-Baranof belt, younging to the east from 60-51 Ma (Bradley et al., 2003); (2) the long geologic history of stationary plutonism in the Pacific Northwest from 60-51 Ma; (3) paleomagnetic data from the Ghost Rocks Formation on Kodiak Island suggest formation between 33° ± 7° and 47° ± 6.5° N latitude (Bol et al., 1992; Plumley et al., 1983); (4) the similarity of the Baranof Schist and the Leech River Schist, as both experienced nearly identical high-pressure, high-temperature metamorphism c. 50 Ma; and (5) the flare up of plutonism along the Coast Plutonic Complex (CPC) c. 50 Ma.

Single-Ridge Hypothesis. The CPW terrane and Sanak-Baranof belt are inferred to have experienced northward translation of 1100 km and this inference is based on fossil evidence, paleomagnetic data, and other geologic evidence (see Cowan, 1982; Cowan, 2003). The Baranof-Leech River hypothesis of Cowan (2003) suggests that schists on southern Baranof Island were contiguous with the Leech River Complex on southern Vancouver Island at 50 Ma based on physical and petrogenic similarities (Cowan, 2003). Both units are twice-deformed biotitic schist and phyllite derived from sandstone-mudstone flysch with similar mineral assemblages and K-Ar cooling ages of approximately 45-35 Ma (Cowan, 2003).

Using the present position of North America as a point of reference, the schists of Baranof Island and the Leech River complex were contiguous units of the 2200 km Chugach terrane at 50 Ma and were situated at approximately the present latitude of the Strait of Juan de Fuca (i.e. ~45° N, see Cowan, 2003). After 50 Ma (the last time of intrusion), the rocks on the southern tip of Baranof Island, along with the rest of the Chugach terrane, were displaced 1100 km north by coast-parallel slip along the Queen Charlotte-Fairweather fault system and their older equivalents (Cowan, 2003). The Queen Charlotte-Fairweather fault system eventually becomes the Border Ranges fault system to the north, which is the inboard bounding fault to the Chugach-Prince William terrane.

Dual-Ridge Hypothesis. It has been suggested that the near-trench magmatism in southern Alaska and the Cascadia margin between Vancouver Island and southern Oregon is related to the subduction of a previously unknown oceanic plate between two coeval trench-ridge-trench triple junctions (Haeussler et al., 2003). This theoretical plate, termed “the Resurrection plate” after the Resurrection Peninsula ophiolite near Seward, would have existed between the Kula and Farallon plates, with TRT triple junctions at the boundaries (Haeussler et al., 2003).

The Dual Ridge Hypothesis attempts to explain both the near-trench magmatism along the Cascadia margin and that of the southern Alaska and assumes that these rocks are

more-or-less in place. In this scenario, the Kula-Resurrection ridge subducts obliquely along the southern Alaska margin near the Seward Peninsula, while the Resurrection-Farallon ridge subducts at the Cascadia margin near Vancouver Island (see Figure 3). As the Resurrection plate continued to subduct, the Kula-Resurrection TRT triple junction along southern Alaska migrated to east, which accounts for the west-to-east age migration of 61 to 50 Ma on the Sanak-Baranof belt (Haeussler et al., 2003). However, along the Cascadia margin, the Siletz River Volcanics, Crescent Formation, and Metchosin Volcanics are dated between 66 and 48 Ma, without a clear age progression, which would suggest near-perpendicular subduction of the Resurrection-Farallon TRT triple junction, which would not have migrated significantly (Haeussler et al., 2003).

The death of the Resurrection plate resulted from the near parallel subduction of the Kula-Resurrection ridge under the North American margin, and this event would have most certainly modified the motion of adjacent plates. Between 56 and 48 Ma, the Kula and Pacific plates experienced a relative counterclockwise rotation of 37°, with 21° of the rotation occurring between 52.4 and 51.7 Ma (Haeussler et al., 2003). The rotation of the Kula-Pacific occurred synchronously with 20° of clockwise rotation between the Pacific and Farallon plates (Haeussler et al., 2003). The modification of the motion of these plates also immediately predates the beginning of the dextral motion on the Queen Charlotte-Fairweather fault system (Haeussler et al., 2003).

The death of the Resurrection plate may have culminated in a very long, margin-parallel slab window, which is a slab-free zone beneath a convergent margin where a spreading center interacts with a subduction zone (Haeussler et al., 2003). Where the spreading center reaches the TRT triple junction, the zone of divergence becomes inundated by asthenosphere, ceasing the growth of the slab due to increased temperatures (Haeussler et al., 2003). The window would result in very young (less than 10 Myr) oceanic crust, which is buoyant, directly under the continental crust of the subduction zone. The decreased difference in density would likely induce high shear stress along the base of the overriding continental crust, which is supported by the record of rapid uplift and

magmatism of the Coast Mountains and Cascade Range at c. 50 Ma (Haeussler et al., 2003).

The Dual Ridge Hypothesis, with the theoretical Resurrection Plate (Figure 3), implies no significant northward terrane transport from 70 to 50 Ma but does address the rapid uplift and magmatism of the Coast Mountains that ceased ca. 50 Ma with its death (Haeussler et al., 2003). This hypothesis however ignores paleomagnetic data supporting the previously proposed 2000 km northward transport of the southern Alaska accretionary complex (Haeussler et al., 2003).

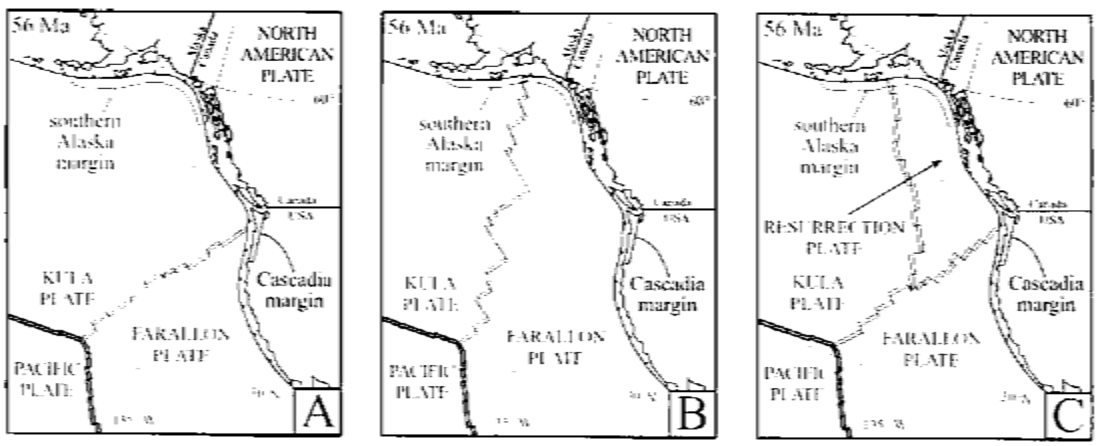

Figure 3. Illustration of single- versus dual-ridge hypotheses, including the theoretical Resurrection Plate used by Haeussler et al. (2003) to explain the Sanak-Baranof suite along the North American margin. (from Haeussler et al. 2003).

Comparison of Single- and Dual-ridge Hypotheses. The primary difference between the two hypotheses is that the dual-ridge hypothesis requires the end-members of the Sanak-Baranof Belt to both be formed in place while the single-ridge hypothesis requires both end-members to have formed to the south and then be transported approximately 2100 km along the North American Margin. The single-ridge hypothesis, explored most comprehensively by Cowan et al. (2003), uses the paleomagnetic data to support the hypothesis while the dual-ridge hypothesis, proposed by Haeussler et al. (2003), dismisses the paleomagnetic data altogether, on the premise that the paleomagnetic data were unreliable. The primary question that remains unresolved is whether or not the

rocks of the Prince William terrane (Orca Group) and Chugach terrane (Valdez Group) were formed in place or at more southern latitudes.

ZIRCON FISSION-TRACK DATING

Zircon ($ZrSiO_4$) is a common mineral in igneous plutonic and volcanic rocks, and due to its resistance to mechanical and chemical weathering it is also a common heavy mineral in sandstone (Wagner and van den Haute, 1992; Bernet and Garver, 2005). Zircon generally has a high uranium content of between 300 and 6000 ppm (Wagner and van den Haute, 1992). Zircon dating methods include U/Pb and (U-Th)/He isotope dating, and zircon fission-track (ZFT) analysis, which is the focus of this paper. Fission-track dating has its roots in Schenectady, NY, where from 1963-1964 General Electric physicists P. Buford Price, Robert M. Walker, and Robert L. Fleischer developed a new dating method based on the natural decay by spontaneous fission of ^{238}U (Wagner and van den Haute, 1992). This method differed from contemporary radioisotope dating methods as it did not require measurements of isotope abundances through mass spectrometry, but rather by counting the density of damage tracks created by spontaneous fission (Wagner and van den Haute, 1992).

Fission tracks are created when a fast-charged fission fragments pass through an insulating solid to create a narrow trail of damage along its path (Wagner and van den Haute, 1992). The resulting “latent track” in zircon usually varies in length between 10 to 15 μm and has a width on the order of a few nm, and is obviously invisible to the naked eye (Wagner and van den Haute, 1992). The tracks become highly susceptible to further damage by chemical reagents, and with chemical etching the tracks become larger and therefore visible with the aid of an optical microscrope at magnification of 1000x to 1600x (Wagner and van den Haute, 1992).

Zircon fission-track analysis is ideal for determining stratigraphic ages of sedimentary strata in volcanically active areas, studying the long-term exhumation history of convergent mountain belts with little active volcanism, dating low-temperature thermal

events, and determining tectonic and climatic factors that shape the evolution of mountainous regions (Garver et al., 1999; Bernet and Garver, 2005). A recent development in the application of DZFT analysis uses the FT ages from stratigraphic sequences to reconstruct source region exhumation, which has shown promise for understanding the long-term relationship between tectonics, topography, climate, erosion, and sedimentation in orogenic settings (Garver et al., 1999).

The source regions for sedimentary detritus, or sediment provenance, of sandstones generally have distinct thermotectonic signatures that are retained in the erosional detritus (Garver et al., 1999). In orogenic settings, these thermotectonic signatures tend to fall in one of three categories: 1) source regions progressively exhumed by constant erosion; 2) source regions unroofed by tectonic processes; or 3) source regions characterized by high geothermal gradients and active volcanism (Garver et al., 1999).

Through FT analysis it is possible to determine the age of a single zircon grain that may have a cooling age that can range from several hundred thousand years to over a billion years (Montario and Garver, 2009; Garver and Wold, 2011). Because fission tracks in zircon grains have an annealing temperature of ~240°C ± 30°C, they are fairly resistant to thermal annealing, or resetting, in typical sedimentary basins following deposition (Bernet and Garver, 2005). The resistance to annealing of fission tracks in zircon makes it more suitable than other low-temperature thermochronometers (i.e. Helium dating and apatite FT analysis) for identifying the cooling ages of source terrains because these other methods are compromised more readily with respect to provenance information (Bernet and Garver, 2005). The primary target of DZFT analysis has historically been ancient sandstones, with the ideal sample being ~2 kg of medium-grained arkosic (feldspar-rich) sandstones, though there are a variety of applicable sandstone compositions (Bernet and Garver, 2005).

In the first few years of FT dating, ages were determined using the absolute approach (i.e. λ_f, which is based on the fission decay rate and is assumed to be known), where an equation is used to compare the ratio of spontaneous fission tracks in the etched detector

to the amount of ^{238}U in the sample (Wagner and van den Haute, 1992). This approach has been universally replaced by the zeta method, which involes the use of a constant (ζ), which essentially replaces the need to know λ_f, which is poorly known (see discussion in Wagner and van den Haute, 1992). Using the zeta method, the amount of ^{238}U per unit volume is determined by irradiating zircon grains mount in Teflon® with an affixed piece of freshly cleaved mica and an external detector. The sample and affixed mica are bombarded with neutrons in a nuclear reactor, which induces tracks that are records in the mica. The number of tracks induced in the mica provides the amount of ^{235}U per unit volume, as ^{235}U is the fissile isotope of uranium affected by thermal neutron irradiation (Wagner and van den Haute, 1992. The number of neutrons that bombard the sample, known as fluence, is determined by counting the tracks induced in a glass dosimeter with known ^{238}U content. As counting can be inherently subjective, standards of known ages are also irradiated and counted to determine a mean zeta (ζ) value to be used in determining the age of unknown samples. The standards used in the present study are the Buluk Tuff, Fish Canyon Tuff, and Peach Springs Tuff.

Track Stability. Fission tracks in zircon anneal at ~240° C ± 30° C, and this is known as its effective closure temperature; below this temperature, tracks are fully recorded in the crystal (Brandon et al., 1998). Above this temperature, tracks may shorten or entirely disappear, referred to as partially annealed or totally annealed, respectively (Bernet and Garver, 2005; Garver et al., 2005). Zircons anneal differentially depending on the degree of radiation damage, whereas highly damaged zircons will anneal at lower temperatures and less damaged zircons require higher temperatures to anneal (Bernet and Garver, 2005; Garver et al., 2005). Zircons with significant radiation damage, partly disordered crystalline structure, and low closure temperature (180-200° C) are referred to as Low-Retentive Zircon (LRZ). Nearly crystalline zircons with little to no radiation damage anneal at or above 280-300° C, and are known as High-Retentive Zircon (Bernet and Garver, 2005). It is important to determine if any partial or total annealing is evident in DZFT analyses as detrital zircons in sedimentary strata commonly undergo burial and heating (Bernet and Garver, 2005). Rocks in orogenic belts that have undergone burial and heating and were then exhumed generally have populations of grains that have been

fully reset, partially reset, or have not been reset at all, and in this last case the grain still retains provenance information (Bernet and Garver, 2005). Grains that have been partially or totally reset will provide FT ages younger than those that have not been annealed at all (Bernet and Garver, 2005).

Zircon Partial Annealing Zone. Fission tracks in zircon form from the spontaneous fission of ^{238}U. These tracks are zones of intense disorder that anneal and disappear at high temperatures, but are fully retained at low temperatures (Garver, 2008). The temperature range between annealing and retention for fission tracks in zircon is known as the Partial Annealing Zone (PAZ) (Garver et al., 2005). For simplicity, the concept of an effective closure temperature (T_c) is favored over the PAZ (Reiners and Brandon, 2006). The effective closure temperature represents the temperature of near full track retention, and therefore closure of the FT system (Bernet and Garver, 2005). There is, however, some variance in the exact effective closure temperature as it is sensitive to the rate of cooling and internal radiation damage in the zircon (Garver et al., 2005). The common estimates for the effective closure temperature of zircon in typical orogenic settings is 240° ± 30° C (Bernet and Garver, 2005; Bernet et al., 2002) and 250° ± 40° C (Garver et al., 2005), but may be as low as 205° ± 18° C in slow-cooled systems (Bernet, 2009). Past research suggests that in most cases the 90% retention temperature ($T_{90\%}$), or the temperature at which 90% of tracks are retained for zircon is ~240° C, assuming depths of about 7.5-8 km with a typical continental geotherm of 30° C/km and an average surface temperature of ~10° C (Bernet and Garver, 2005).

Radiation Damage in Zircon. Individual zircons grains have different total accumulated radiation damage depending uranium and thorium concentration, the time since initial cooling, and the subsequent thermal history of the grains (Garver et al., 2005). Radiation occurs in zircon grains as fission damage from ^{238}U and α-recoil damage from U and Th, and it is the latter that is most important (Garver et al., 2005). As radiation damage accumulates, zircon becomes increasingly disordered, transforming from fully crystalline to amorphous, or metamict (Garver et al., 2005). At the metamict state, the crystal is essentially a glass and its material properties are that of complete

disorder (Garver et al., 2005). Zircons at or near what is referred to as the crystalline-to-metamict transition are too far damaged to have fission tracks etched and revealed using standard laboratory procedures (Garver et al., 2005).

Annealing of fission tracks occurs when zircons with tracks are heated to temperatures sufficient to heal track damage. Zircons have different levels of retention of fission tracks due to differences in accumulated radiation damage and the most important issue is how radiation damage affects resistance to annealing. Zircons that are highly resistant to annealing are known as high retentive zircons (HRZs) and these crystals have relatively high closure temperatures due to low accumulated radiation damage (Garver et al., 2005). Low retentive zircons (LRZs) on the other hand have a low effective closure temperature and are poorly resistant to annealing due to highly accumulated radiation damage (Garver et al., 2005).

The annealing, or repairing of radiation damage in zircon is time- and temperature-dependent, but the exact processes are not entirely understood (Garver et al., 2005). It is accepted that full annealing can occur for both HRZs and LRZs when temperatures are great enough to fully anneal, regardless of the degree of radiation damage (Garver et al., 2005). Research done on rapidly cooled rocks from the Southern Alps in New Zealand suggest that temperatures in excess of 300° C are effective in fully annealing of all tracks in zircon (Green et al., 1996). The second process of annealing that is relatively well understood is the full annealing of LRZs. In this case, only less retentive grains are fully reset and high-retentive grains are either partially reset or not reset at all (Garver et al., 2005). Partial resetting of the HRZs would reduce the lengths of the tracks and in turn produce a reduced apparent age of the grain (Garver et al., 2005). Complete thermal resetting of both LRZs and HRZs resets both fission tracks and α-damage; however, temperatures sufficient to fully anneal only LRZs is insufficient for full annealing of α-damage, suggesting that the annealing of α-damage and fission tracks do not occur at the same temperature (Garver et al., 2005). Tagami and O’Sullivan (2005) note that the rate at which zircon fission tracks anneal is also dependent on chemical composition,

pressure, and the accumulation of radiation damage, whereas spontaneous fission tracks in older zircons anneal slower than those in younger zircons.

Therefore we are concerned here with two different thermal histories for rocks: one brought from depth and one that was at near-surface conditions and was then heated by burial (see Figure 4 from Garver, unpublished). This cartoon helps explain the effects of the concepts of the PAZ or T_c and also on annealing of already formed tracks on determining the significance of a time-temperature history, or thermochronology of zircon. Rock A has undergone an exhumation from great depth, in which it has passed through the PAZ and ultimately reached the surface. Prior to passing through the PAZ, Rock A had been heated to well above 250° C and then cooled as it proceeded to the surface. At depth, fission tracks do not get retained due to the high temperatures that anneal them immediately after formation, but as the rocks cool below the effective closure temperature, fission tracks begin to form and are fully retained. In the case of Rock A, the high temperatures have kept α-damage from accumulating. Another common scenario is shown in Path B. In this time-temperature history, Rock B starts its path at the surface so the zircons have had plenty of time to accumulate fission tracks and α-damage, which causes grains to react in very different ways to the annealing process. The rock is then buried to within the PAZ, and then exhumed back to the surface. In this case, zircons would have accumulated radiation damage in the form of fission tracks and α-decay while at the surface and during burial. At its deepest point in the zone of annealing, the LRZ zircons will undergo annealing of at least a small portion of the tracks that have already formed. The extent of the annealing can range from only partial annealing of a few of the LRZs to fully annealing the LRZs and HRZs experiencing no resetting or partial resetting, depending on the temperature reached at depth. Rock B, however, does not undergo full annealing of all tracks as temperatures are not great enough in the PAZ. As Rock B is exhumed, the formation of fission tracks will begin to occur again as temperatures decrease. Thus, FT analysis of the zircon from Rock B will likely produce a wide variety of cooling ages that include fully annealed and partially annealed grains.

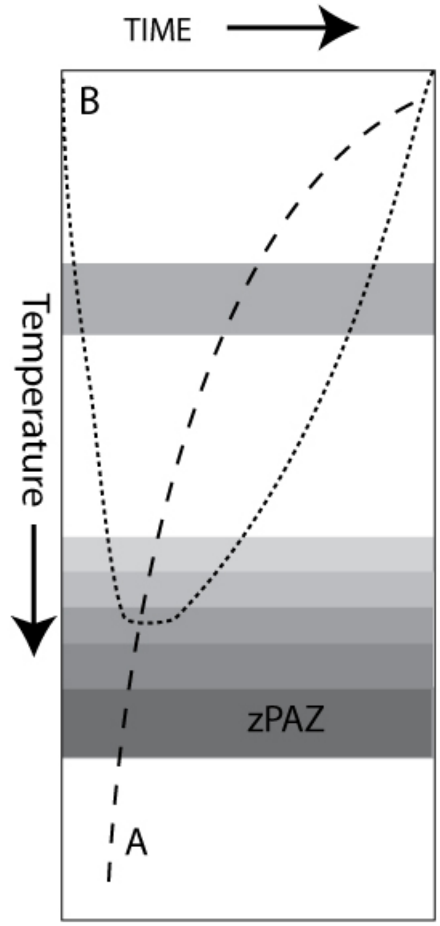

Figure 4. Cartoon of theoretical paths of rocks exhumed from great depths (A) and rocks that are buried and then exhumed (B). Path A experiences little to no α-damage, while Path B accumulates a great degree of α-damage (source: Garver, unpublished).

The strategy for dealing with heterogeneous annealing is the use of statistics behind a peak-fitting method, which isolates the youngest population of grain ages (Brandon et al., 1998; Bernet and Garver, 2005). The age determined for the youngest group of grain ages is referred to as the minimum age of the fission track grain-age distribution (Brandon et al., 1998). If a sample has always been at temperatures less than the PAZ, then the minimum age indicates a young cooling event in the source region (Brandon et al., 1998). If a sample has reached temperatures at or above the PAZ, then the minimum age indicates the time when the sample cooled below the PAZ, allowing fission track formation to resume in those grains that were annealed (Brandon et al., 1998).

METHODS

Sample Collection. Six samples of medium- to coarse-grained sandstones were collected from the Paleocene Orca Group along the northeast part of Prince William Sound near Cordova, AK (Figure 5; Figure 6) for zircon fission track analysis (see Appendix A). In addition, one sample of Paleocene granite, which intruded the Orca Group, was collected from the same area (Sheep Bay). The seven sample sites form a transect line through the marine, coastal, and inland components of the northeastern part of Prince William Sound. Approximately 4 to 5 kg of broken and crushed sample was collected from each site.

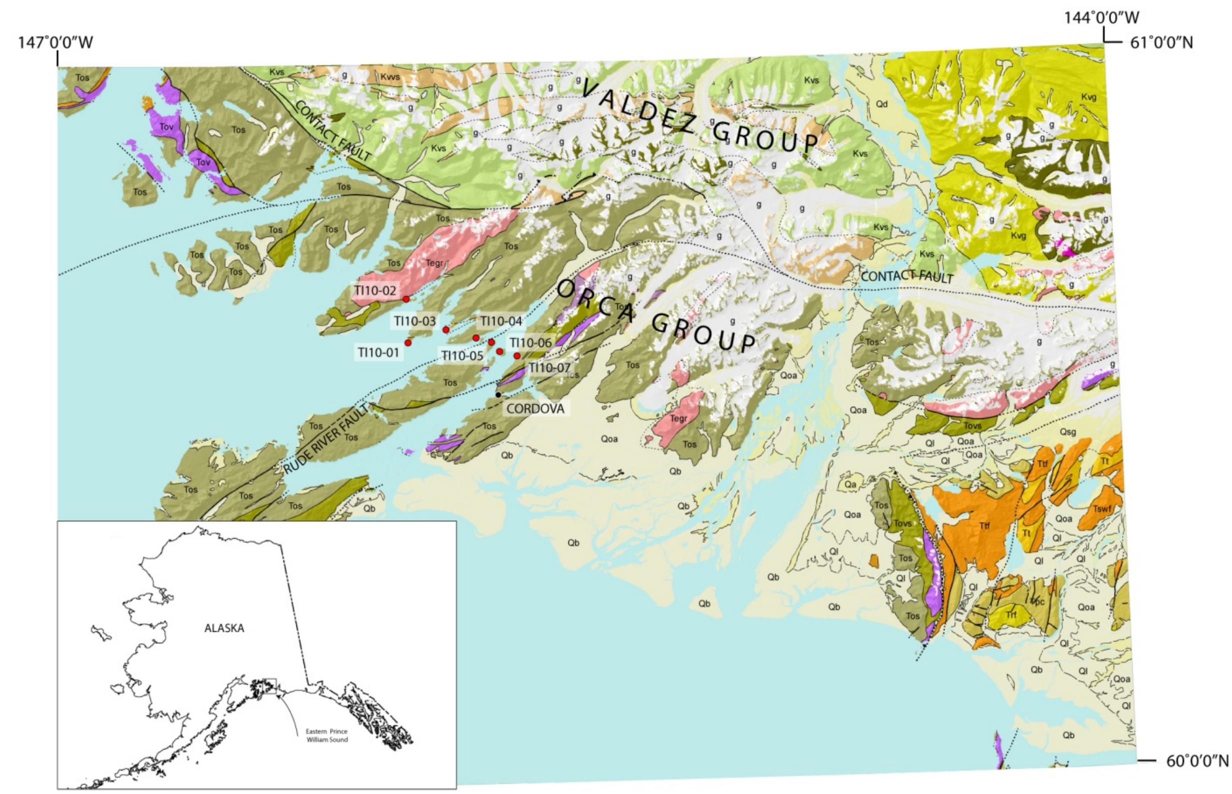

Figure 5. Location map of seven samples collected for detrital zircon fission track analysis near Cordova, AK (modified from USGS digital Geologic map series).

Figure 6. Exposed turbidite beds of the Orca Group on Sheep Point in Orca Bay.

The samples were collected along the shoreline of Prince William Sound to the northwest of Cordova, AK. Samples TI10-01, TI10-02, TI10-03, TI10-04, TI10-05, TI10-06, and TI10-07 were reached by an 18-foot skiff with a 40 HP outboard motor supplied by Cordova Coastal Outfitters. Freshly exposed rock samples were bagged, labeled, and described for each sample. Global Positioning System measurements were taken for latitude and longitude, as well as elevation.

Zircon Extraction. In the Union College Fission Track Lab, samples were processed according to standard zircon extraction methods (see Bernet and Garver, 2005; and Union College Fission Track Laboratory Manual). Samples were first crushed into small gravel-sized particles using a Chipmunk jaw crusher. The gravel-sized particles were then pulverized to very fine sand using a Bico® pulverizer with a Torit® dust collection system attached to remove the superfine particles. The fine sand was then separated

using a Gemini® Gold Rogers Table, which separates heavy and light minerals into four separate fractions that reflect relative density of the expected material. The lightest of the four were removed to storage (fraction D) and the three heaviest fractions (fractions A, B, and C) were then dried in an oven at 40° C for 24-48 hours prior to heavy liquid separation.

Once dried, the fraction to be further separated was then put through a combination of sieves, so that particles +300 μm and -63 μm were removed. After only particles -300 μm and +63 μm in size remain, 200 ml of each sample were set aside for heavy liquid separation. The 200 ml that was processed was comprised of either entirely the A-fraction, or heaviest minerals, or a combination of the A-fraction (likely to contain the heaviest minerals), or a combination of the A-fraction and the B- and C-fraction. The 200 ml of each sample then underwent heavy liquid separation, first by tetrabromoethane (TBE), which has a density of 2.95 g/cm^3, so that only particles with a density greater than 2.95 g/cm^3 would settle out. The heavy minerals were then passed through the Frantz® magnetic separator at a tilt of 15° to incrementally remove particles magnetic up to 1.7 Amps. Particles non-magnetic at 1.7 Amps then underwent the second round of heavy liquid separation, this time through methylene iodide, which has a density of 3.3 g/cm^3. Some of the slightly magnetic fraction at high amperage (1.0 to 1.7 Amp) contained detrital zircon, but these were not further separated and were not used in analysis. The methylene iodide (MI) separation ideally separates the higher density zircon crystals, which settle to the bottom of the separatory funnel, from the lower density apatite crystals, which float on top of the heavy liquid. The zircon fraction was then inspected using an Olympus® binocular microscope to assess the quality of the crystals. In general the zircon yield was excellent for these samples.

Sample Preparation. Following separation and inspection of the zircon, grains were mounted in individual 2 x 2 cm^2 PFA Teflon® squares that had been heated on a Corning® hot plate to about 330° C. For each of the seven samples, three Teflon® mounts were made (a, b, and c) as there was an abundance of high-quality zircons and so that different etch times could be used (see Appendix A). Mounts were also made of three

different age standards: the Buluk Tuff, Fish Canyon Tuff, and Peach Springs Tuff, the ages of which are well-known and widely accepted. With both standards and unknowns, a total of twenty-seven mounts were made: three mounts of each of the seven unknowns and two mounts of each of the three known standards. The zircon-embedded Teflon® mounts were then polished on a Buehler AutoMet® 200 Powerhead and EcoMet® 3000 Variable Speed Grinder/Polisher; first using a 9 μm diamond slurry, and then again with a 1 μm diamond slurry. The first round of polishing exposes the zircon grains, which were previously embedded in the Teflon®. The first round of polishing (9 μm) was done at 420 rpm for 10 minutes at 18 pounds of pressure. The second round of polishing (1 μm) was done at 420 rpm for 8 minutes at 15 pounds of pressure to remove polishing scratches from exposed zircon grains, leaving a liquid-clear finish. For each round of polishing, the pressure was distributed over three sample mounts and three blanks for even polishing.

The finely polished and mounted zircon grains were then inspected at 500x magnification to assure the clarity and quality of the polishing. After polishing, the mounts were etched. The etching involved placing the polished mounts in a NaOH-KOH eutectic at 228°C for 15-30 hours. The strong base solution etches the fission tracks that have occurred naturally in the zircons due to spontaneous radioactive decay. The ideal etch time differs from sample to sample as younger grains require longer etch time than older grains, which have a higher degrees of radiation damage (see Bernet and Garver, 2005). To account for the variability of grain ages and the variation in etch times the a, b, and c mounts for each of the unknowns were etched for different times (see Appendix A). Once removed from the etchant, the mounts were pressed between two glass plates for 20 minutes at 228° C and then allowed to cool to room temperature. After flattening, the mounts were sonicated in 100 ml of 6N hydrochloric acid (20%) for 10 minutes. The mounts were then rinsed in distilled water, and then again in ethanol, and then left to dry on a hot plate (75° C for 5 minutes). The cleaned and flattened mounts were then affixed with a low-uranium, pre-annealed, freshly cleaved flake of mica with a thickness of about 0.2 mm. Three Corning CN-5 glass dosimeters, which have a known ^{238}U content of 11 ppm, were also affixed with freshly cleaved flakes of mica.

The mica-affixed mounts and glass dosimeters were then arranged to be sent away for irradiation at the Oregon State Nuclear Reactor. The mounts were arranged in a stack, taped, and then placed in a Poly tube with a glass dosimeter at the top, bottom, and middle of the stack to determine the fluence applied to each position in the stack during irradiation. The order of the glass dosimeters and zircon mounts was clearly documented, and the mass of the Poly tube, the stack of mounts, and the Styrofoam used for packing were determined for calculation of radionuclides expected after irradiation. The tube of samples (Irradiation U48Z) was then shipped to the nuclear reactor at Oregon State University, where the stack of samples received a nominal fluence of $2x10^{15}$ n/cm^2.

Following irradiation, samples were allowed "cool down" for several weeks while radioactive isotopes with shorter half-lives decayed. The stack of glass dosimeters, Teflon® mounts, and mica detectors was then separated and the mounts and detectors were pierced using a carbide-tipped scribe to create registration points. These registration points were used to align the mounts and detectors for the counting process. The mica detectors were then etched in 48% hydrofluoric acid for ~18 minutes at room temperature (20-22° C). The mica was then cleaned using NaOH and water, then ethanol, and finally left to dry on a hot plate at ~100° C. The Teflon® mounts and their corresponding mica detectors were then mounted as mirror images on a glass slide using thin section epoxy and a glass cover slip to account for a difference in height.

Fission Track Counting. Spontaneous fission tracks in zircon and induced tracks in the mica detector were then counted at 1250X using an automated stage on a BMAX-60 Olympus microscope using reflected and transmitted light. Grains on the Teflon® mount were marked using a CalComp digitizing tablet, connected to FTStage v2.0 software. A Kinetik Automated Stage driven by FTStage v2.0 was used to navigate to marked grains and their corresponding induced tracks on the mica detector.

Following grain marking, grains were further examined and categorized by their countability. Grains were selected for counting if they met several criteria: etch figures were oriented parallel to the c-axis of the grain; free of inclusions; not strongly zoned; distribution of uranium is approximately even; countable area was of sufficient size; and optical clarity. Grains were counted regardless of uranium concentration as long as tracks were well-etched and clearly visible (see Bernet and Garver, 2005). Tracks were counted in the Teflon® mounted zircon grains using a 10 x10 counting grid on the microscope eyepiece. The induced tracks in the corresponding counting area on the mica detector were then counted to determine uranium concentration.

The zeta calibration factor was determined by counting spontaneous and induced tracks in ten grains from nine standards of known age from the Fish Canyon, Buluk, and Peach Spring Tuffs (see Appendix B). The track counts were used in the Zetamean program and the resultant zeta calibration factors for each of the nine standards were averaged to create a personalized and unique zeta factor. The mica detectors affixed to the glass dosimeters were counted to determine the fluence distribution throughout the stack. The zeta calibration factor, fluence calculation, and track counts were then used to calculate a single grain age using ZetaAge (see Appendix C).

For each of the unknown samples, 36 to 45 grains were counted between the three mounts. To understand with the wide range of grain ages present in the samples, statistical techniques were employed to determine component populations (see Bernet and Garver, 2005). Grain-age data for each of the samples were plotted on histograms and probability density plots using Binomfit (Brandon, 1996). Populations were evaluated using binomial peak-fitting in Binomfit. The histograms, PD plots, and grain-age populations were plotted using SigmaPlot, and the peak ages of populations were compiled in Table 2.

Track-Length measurements. Confined horizontal track lengths were measured using an optical microscope by J.I. Garver. Track lengths were measured in all samples using a digitizing tablet calibrated to the microscope field of view using a drawing tube. Prior to

measurement, the system was calibrated by repeatedly measuring a 10 μm increment on a stage micrometer, and the analytical precision is a function of the error in those calibration measurements. On a single mount, all reflective grains with flat polished surfaces were marked and then tracks were measured on all grains, regardless of track quality, countability, etc. For these samples, this meant that we attempted to measure tracks in about 200 or 300 grains. All measurements of tracks in unknown samples were made using reflected light only at 1250x and only horizontal confined tracks (HCT) with clear end points were measured. Most are track-in-track, and only rarely were track-in-cleavage measured. This approach means that we typically measure two or less tracks per grain. Grains with high track density and grains with c-axis-parallel cracks (cleavage in many cases) tend to yield more HCT than other grains with lower track densities and those that are crack free. Thus, there is an important caveat that these data over-represent higher track density grains, which tend to be older and those with higher uranium. We avoided measuring HCT in grains with abundant inclusions. For all tracks, the c-axis was first measured, and then track length was measured, so we know the angular relationship between track and C-axis. For almost all samples we were able to measure at least 100 HCT.

Etch figure measurements. The length of etch figures on FT counted grains from a single sample (TI10-07), where etch pits were parallel to c-axis, were measured using SEM images at ~5000x. After FT determination, Teflon® sample mounts were coated using a Denton vacuum sputter coater with a gold-palladium target at ~50 mTorr using argon gas using power setting of 20% for 45 seconds. The resulting Au-Pd coating is estimated to be ~5-10 nm thick. The FT mount was then attached to a standard flat top SEM sample holder, and copper tape was used to hold the mount and silver (Ag) paint was applied to complete a conductive path.

All SEM images were made on a Zeiss EVO 50 scanning electron microscope with a Everhart-Thornley detector. Images were taken with under high vacuum, at least 10-5 Torr, with an accelerating voltage (EHT) of 15 keV, a working distance of ~10-15 mm, and a beam current of 100-150 μA, and most images had a nominal magnification of

5000x. All etch figures were measured digitally using ImageJ software. All etch pits were measured on each single image and a second image was used if the total was less than twenty. Statistics on pit-length measurements were then made on the measurements for all measurements by determining the mean, mode, standard deviation, and standard error. The same was then done for the five largest pit-lengths, and all of these data appear in Appendix F.

Raman spectroscopy. Raman measurements were made with a Bruker Optics Senterra® Spectrometer coupled to an Olympus® BX51 reflected light microscope. Raman spectroscopy was performed using a 633 nm external He-Ne laser. The spectrometer includes a computer controlled three-grating turret with a spectral resolution up to 3 cm-1 and automatic laser and Raman frequency calibration. Samples were first located at 100x using bright field objectives, and the measurements were made with video camera and long working-distance dark field objectives at 500x. The signal was captured by a low noise 1024x256 pixel thermoelectric-cooled CCD detector. Measurements were made with a laser power of 20 mW. Integration time of 5 s during signal acquisition and 5 s for background acquisition.

We made these measurements on grains that had already been evaluated for their spontaneous track density of fission tracks. Thus the samples had been ground, polished to 1 μm, etched for ~25 hr in a NaOH:KOH eutectic, and neutron irradiated with ~2 x 10^{15} n/cm^2. Neither the etching, track revelation, nor the neutron bombardment affects the Raman scattering in a significant way (Marsellos, 2009). Grains analyzed are typically 100-150 μm long and 50-100 μm wide.

Grains previously counted for FT analysis were mapped in their Teflon® mount, and that map was used for navigating around the ~400 mm^2 Teflon® grain mount. Once located, four measurements were made on each grain, and for each measurement the spot location was changed slightly, but we tried to stay in the area that was counted for FT analysis. For samples with a very strong peak to background ratio, we used a simple rubberband background correction, but for those with a more elevated background or a background

broadly concave (likely due to slight fluorescence), we used a concave rubberband background correction. We then used FitYK® for peak fitting and we concentrated our efforts on the V_1SiO_4 (~974 cm-1) symmetric stretching and the V_3SiO_4 (~1007 cm-1) antisymmetric stretching (i.e. Marsellos and Garver, 2010).

RESULTS

All but one of the zircon fission track grain-age distributions obtained from the Orca Bay area near Cordova, AK fail χ^2, which is typical of detrital samples and indicates a heterogeneous sediment source or variable annealing (Bernet and Garver, 2005; Table 1). Sample TI10-03 passes χ^2 at 15%, but it still shows multiple component ages (Table 2). When data from all Orca Group samples are compiled, there is a majority cooling age population at 48.9 ± 1.7 Ma (68%) and a notable younger population at 31.2 ± 1.5 Ma (19%) (Table 2). There is also small populations at 78.8 ± 7.4 Ma (9%) and older. However, grain-age distributions and subsequent peak-fitting reveal significant homogeneity in populations for samples derived from west and east of the Rude River fault, therefore from this point forward, samples will be grouped and analyzed according to their geographic relation to this fault (Table 2). The Sheep Bay Granite sample (TI10-02) has over-dispersed grain-ages with ages similar to those determined from surrounding Orca Group samples.

Samples west of Rude River fault. Detrital zircon fission track ages for the Orca Group west of the Rude River fault, represented by samples TI10-01, TI10-03, and TI10-04 (Figure 7), have a combined majority grain population at 49.2 ± 2.3 Ma, represented by 82% of grains, with a secondary older population at 81.2 ± 8.7 Ma made up of 16% of grains. (Table 2, Figure 8). The easternmost and most proximal to the Rude River fault for this group of samples (TI10-4) also has an additional young population at 23.4 ± 8.4 Ma that is made up of 6% of grains within that sample (only 2% of grains in the combined results) and is inferred to reflect a similar signal detected by samples lying to the east of the fault (see below). For comparison purposes, TI10-04 has a unique P1 population at 23 Ma in addition to P2 and P3 populations that correlate to the P2 and P3

peaks of samples TI10-01 and TI10-03 (Table 2). The P2 population, which is dominant, ranges in age from 47 to 51 Ma, while the P3 population consists of ages between 76 and 88 Ma (Table 2). It is important to note that these three samples consistently have between 77% and 90% of grains in the P2 population, as well as 10% to 23% of grains comprising the P3 population (Table 2).

Table 1: Zircon fission track data, Orca Group and Sheep Bay Granite

Sample	ρ_s	N_s	ρ_i	N_i	ρ_d	N_d	n	χ^2	Age*	-1σ	+1σ	U ± 2se
Orca Group (west of Rude River fault)												
TI10-01	9.24 x 10^6	1541	1.02 x 10^7	1706	3.40 x 10^5	2155	36	0.0	52.1	-2.4	+2.5	367 ± 21
TI10-03	8.19 x 10^6	1269	8.92 x 10^6	1381	3.32 x 10^5	2111	40	15.0	52.8	-2.5	+2.6	330 ± 21
TI10-04	9.97 x 10^6	1505	1.08 x 10^7	1635	3.26 x 10^5	2089	43	0.0	50.1	-2.3	+2.4	408 ± 24
Orca Group (east of Rude River fault)												
TI10-05	8.87 x 10^6	1613	1.18 x 10^7	2151	3.21 x 10^5	2067	45	0.0	37.6	-1.7	+1.8	453 ± 25
TI10-06	9.46 x 10^6	4631	1.17 x 10^7	5735	3.15 x 10^5	2046	45	0.0	35.8	-1.5	+1.5	457 ± 21
TI10-07	1.13 x 10^7	5446	1.22 x 10^7	5891	3.10 x 10^5	2024	45	0.0	36.3	-1.7	+1.7	487 ± 24
Sheep Bay Granite												
TI10-02	7.83 x 10^6	2518	1.34 x 10^7	4303	3.34 x 10^5	2137	42	0.0	32.6	-1.3	+1.3	487 ± 21

Note: In this table, Age* is the χ^2 age – which is the minimum population - if the χ^2 value is below 5, note that this age overestimates the minimum age compared to the young population determined by binomial peakfitting (see Table 2). ρ_s is the density (cm^2) of spontaneous tracks and N_s is the number of spontaneous tracks counted; ρ_i is the density (cm^2) of induced tracks and N_i is the number of induced tracks counted; ρ_d is the density (cm^2) of tracks on the fluence monitor (CN5) and N_d is the number of tracks on the monitor; n is the number of grains counted; χ^2 is the Chi-squared probability (%). Zircon fission track ages (± 1σ) were determined using the Zeta method, and calculated using the computer program and equations in Brandon (1992). A Zeta factor of 347.50 ± 8.76 (± 1 se) is based on 9 determinations on standard samples from the Fish Canyon Tuff, Buluk Tuff, and Peach Springs Tuff. Glass monitors (CN5) placed at the top and bottom of the irradiation package were used to determine the fluence gradient. All samples were counted at 1250x using a dry 100x objective (10x oculars and 1.25x tube factor) on an Olympus BX60 microscope fitted with an automated stage and a Calcomp digitizing tablet.

Table 2: Binomial component ages of detrital zircon fission-track data, Orca Group and Sheep Bay Granite

Sample	Etch Time (hr)	n	Age range (Ma)	P1	P2	P3	P4
Orca Group (west of Rude River fault)							
TI10-01	20.5-24.5	36	28.6-120.5		47.4 ± 3.1 77.5%	76.2 ± 8.6 22.5%	
TI10-03	20.5-23.75	40	29.6-117.0		50.5 ± 2.9 89.7%	87.8 ± 21.5 10.3%	
TI10-04	20.5-24.5	43	18.9-123.6	23.1 ± 6.4* 6.2%	50.7 ± 3.3 78.7%	85.2 ± 17.4 15.2%	
Combined		119	18.9-123.8	23.4 ± 8.4 1.7%	49.2 ± 2.3 82.0%	81.2 ± 8.7 16.2%	
Orca Group (east of Rude River fault)							
TI10-05	20.5-24.5	45	16.0-135.2	23.0 ± 3.2 15.3%	42.9 ± 2.3 78.1%	100.1 ± 15.6 6.6%	
TI10-06	20.5-24.5	45	24.5-144.3	33.0 ± 1.7 43.3%	51.3 ± 2.3 54.0%	141.5 ± 23.7* 2.7%	
TI10-07	20.5-23.75	45	26.5-149.1	29.5 ± 2.2 15.1%	48.2 ± 2.0 69.1%	90.2 ± 5.8 15.7%	
Combined		135	16.0-149.3	31.0 ± 1.5 28.5%	47.9 ± 1.8 61.2%	84.7 ± 5.3 8.2%	137.8 ± 21.6* 2.2%
Orca Group (ALL)		**254**		**31.2 ± 1.5** **18.7%**	**48.5 ± 1.7** **68.4%**	**78.8 ± 7.4** **8.8%**	**111.8 ± 14.6*** **4.1%**
Sheep Bay Granite							
TI10-02	16-23.5	42	22.3-54.0	28.0 ± 2.4 36.7%	39.7 ± 2.6 63.3%		

Note: Ages denoted with an astrix (*) are poorly approximated because the component population has few grains (generally <10). n = number of dated grains; Uncertainties are cited at 68% confidence interval (about ±1 SE; asymmetric errors are averaged). Zircon grains were dated using standard methods for FT dating using an external detector. Zircons were extracted using standard separation procedures. Fission-tracks were counted on an Olympus BX60 microscope fitted with an automated stage and Calcomp digitizing tablet. Total magnification was 1250x (100x objective, 10x oculars, 1.25 tube factor). A Zeta factor of 347.50 ± 8.76 (± 1 se) was as computed from 9 determinations on standard samples (Fish Canyon Tuff, Buluk Tuff, and Peach Springs Tuff). This table shows all binomial peak fitted ages using Binomfit 1.2.62 (Brandon, 1992)

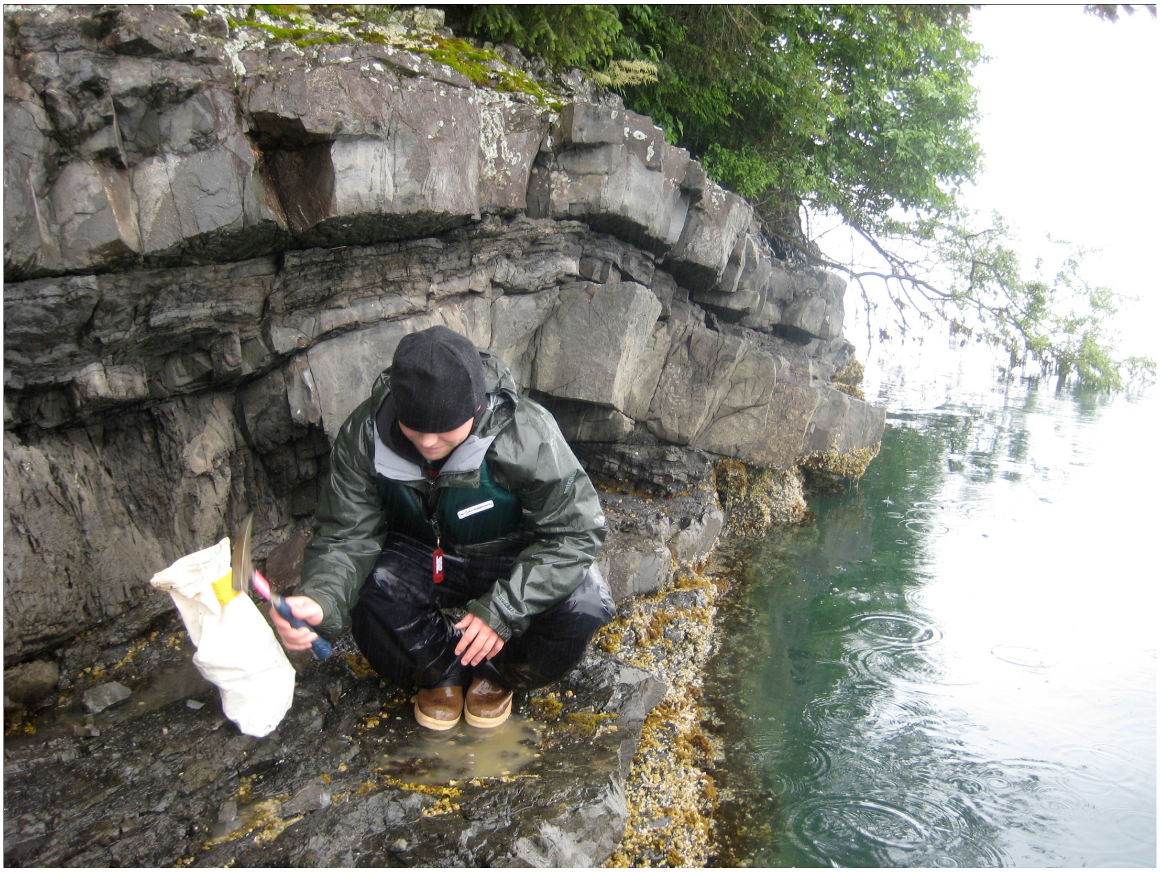

Figure 7. Photograph of the author collecting a sample of the Orca Group (TI10-04) along the mainland shoreline of Orca Bay.

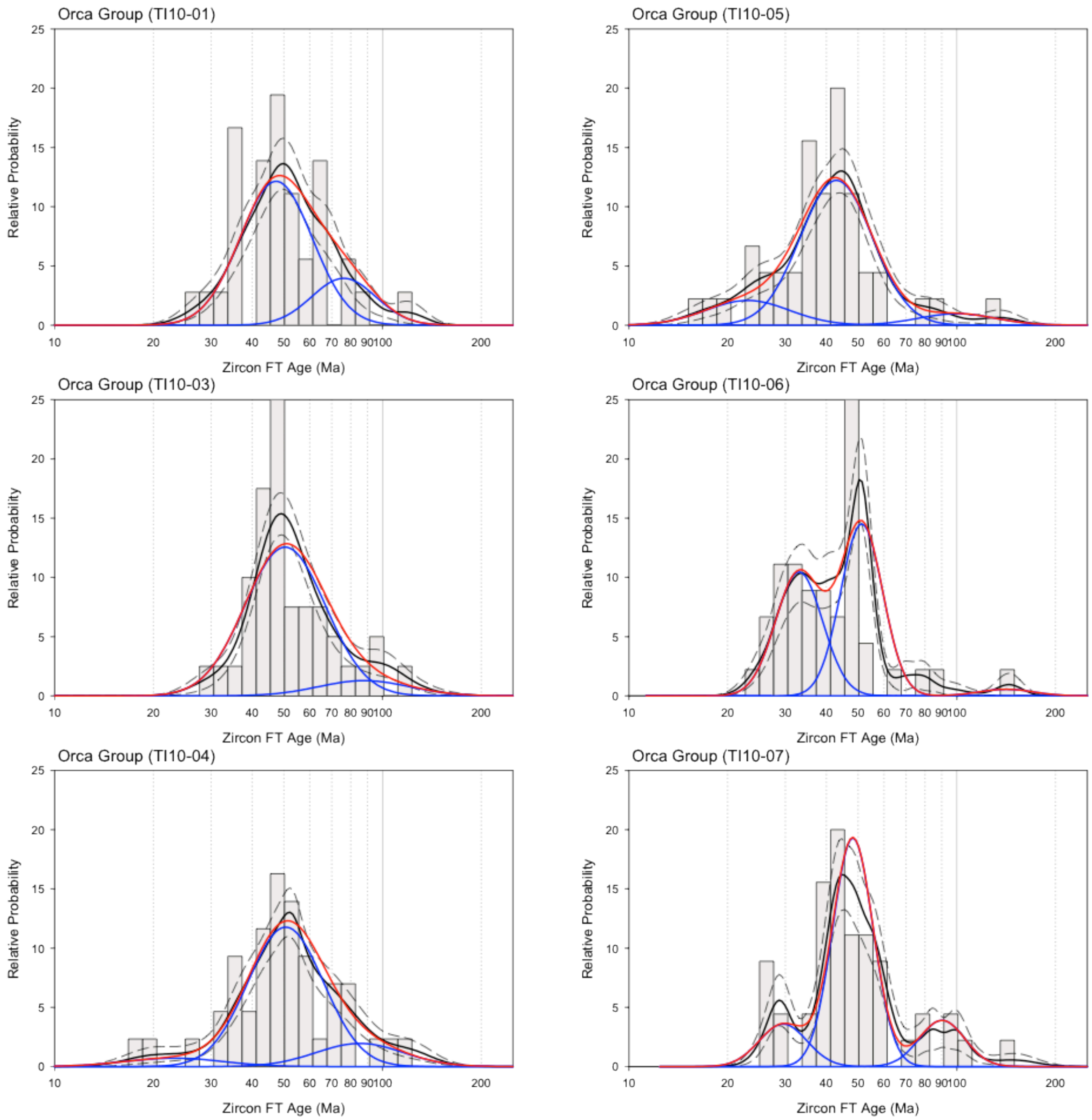

Figure 8. Grain-age distribution plots for Orca Group samples collected west (left) and east (right) of the Rude River fault.

Samples east of Rude River fault. Lying to the east of the Rude River fault are samples TI10-05, TI10-06 (Figure 9), and TI10-07, which together reveal a consistent majority grain-age population of 47.9±1.8 Ma (61.2%) as well as a consistent young population at 31.0±1.5 Ma (28.5%) and older grain-age populations at 85 Ma and older (10.4%) (Table 2; Figure 8). These samples, unlike those to the west of the fault, all have similar P1, P2,

and P3 populations, though when the data are combined, the P3 population can be resolved into two separate populations (Table 2, Figure 8). The P1 population, which ranges in age from 23.0 to 33.0 Ma, is consistently represented 15% to 43% of grains per sample. The P2 population, which is dominant, ranges between 42.9 and 51.3 Ma and has 54% to 78% of grains, and is thus the major population in all samples (Table 2). The P3 population is minor, and it contains 3% to 16% of grains and ranges from 90.2 to 141.5 Ma (Table 2). It is significant to note that the P2 and P3 populations to the east of the Rude River fault are nearly identical to their counterparts west of the fault, with combined population ages of 49.2 and 81.2 Ma and 47.9 and 84.7 Ma, respectively.

Figure 9. Photograph of near vertical beds of the Orca Group (TI10-06) on Observation Island in Orca Bay.

Sheep Bay Granite. The single sample of the Sheep Bay Granite (TI10-02; Figure 10) reveals the simplest grain-age distribution among all samples collected, however it fails

χ^2 and thus the grain ages are over distributed. There is a majority population (P2) at 39.7 ± 2.6 Ma, which is comprised of 63% of the grains counted (Table 2; Figure 11). A minority population (P1), which is similar to the P1 populations east of the Rude River fault and the P1 peak of sample TI10-04, has an age of 28.0 ± 2.4 Ma that is made up of 37% of grains counted (Table 2; Figure 11). Thus, both populations of the Sheep Bay Granite are similar to and slightly younger than the corresponding populations of the Orca Group, both east and west of the fault.

Figure 10. Photograph of the Sheep Bay Granite (TI10-02) exposed along the mainland shoreline in Sheep Bay.

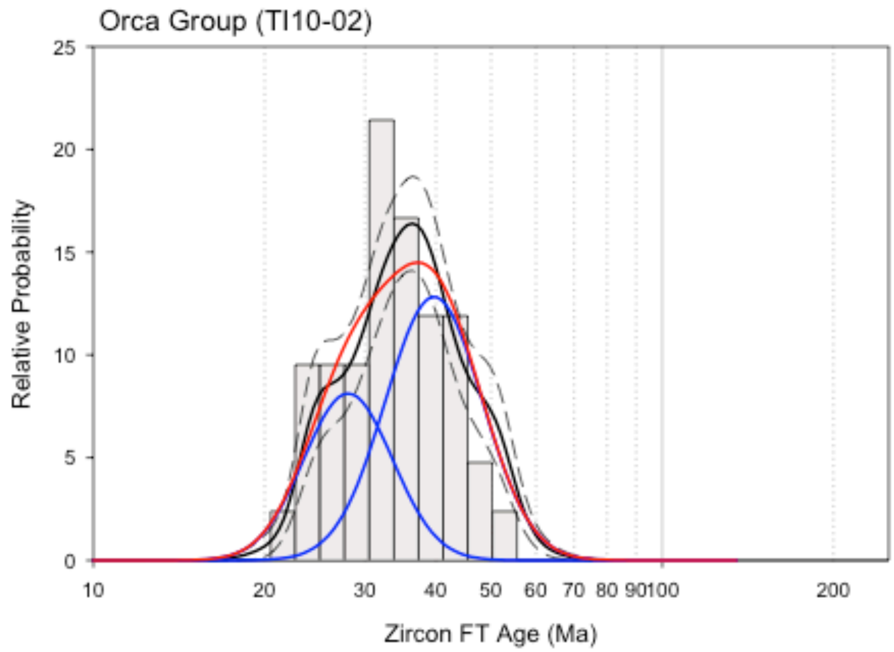

Figure 11. Grain-age distribution for the Sheep Bay Granite.

Uranium. Dated zircons from the Orca Group, both west and east of the Rude River fault, and the Sheep Bay Granite have similar average uranium content (U ± 2se), ranging from 330 to 487 ppm (Table 1). Uranium versus age plots for all Orca Group samples reveal similar trends, where low-uranium grains (<400 ppm) tend to vary significantly in age and includes the oldest apparent ages, while grains with high-uranium concentration (>400 ppm) almost exclusively have younger ZFT ages (Figure 12). The uranium versus age plot for the Sheep Bay Granite shows a much lesser degree of variation for both uranium concentration and age (Figure 13).

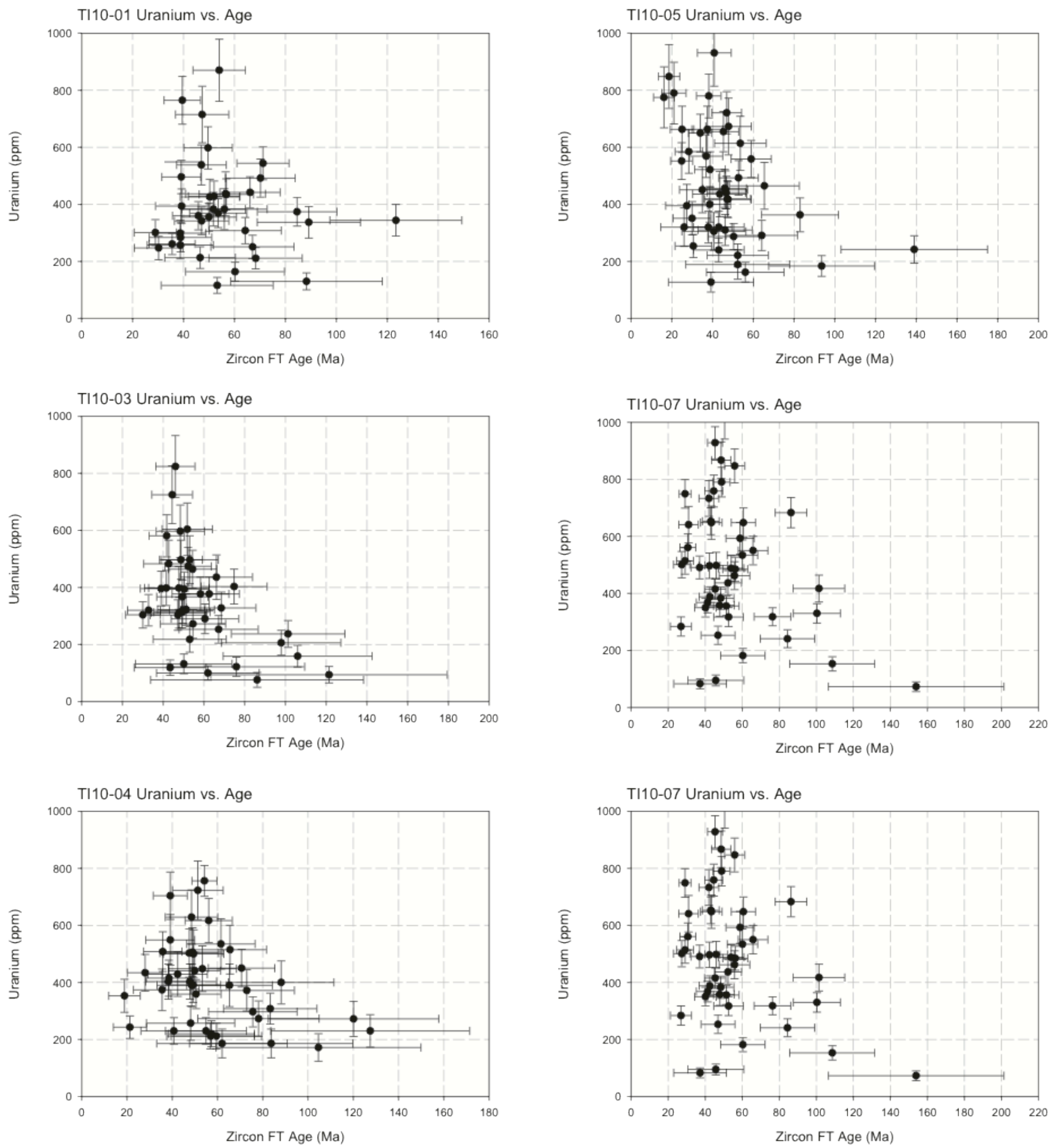

Figure 12. Uranium (± two sigma mean error) versus FT age (± one sigma) plots for Orca Group samples collected west (left) and east (right) of the Rude River fault.

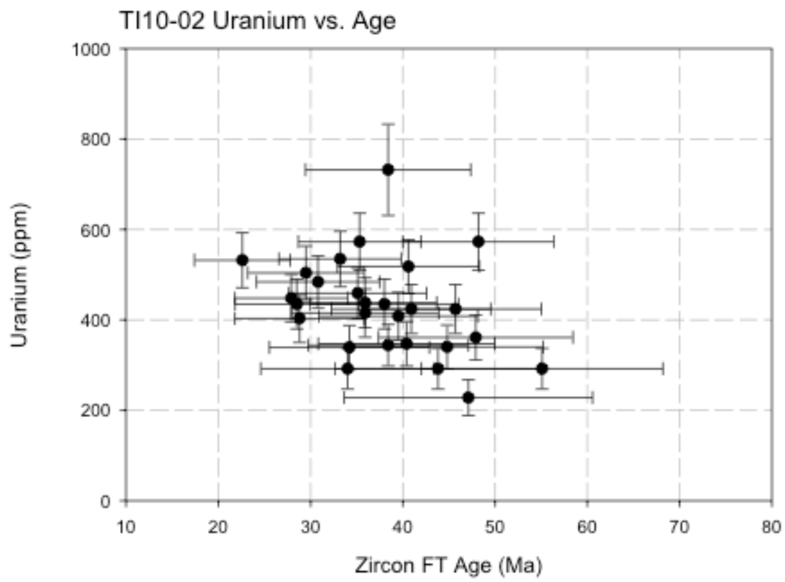

Figure 13. Uranium plot for the Sheep Bay Granite (TI10-02).

Track-length analysis. Track lengths of the Orca Group samples provide further evidence for the difference of samples between those west and east of the Rude River fault. Samples west of the fault have a bimodal track-length distribution with an abundance of shortened tracks (6-7 μm) (Figure 14). Samples east of the fault differ from the west in that they have primarily unimodal track-length distributions with mostly larger tracks (10-11 μm) (Figure 14). The Sheep Bay Granite has a unimodal track-length distribution with mostly longer tracks (10-11 μm) (Figure 15).

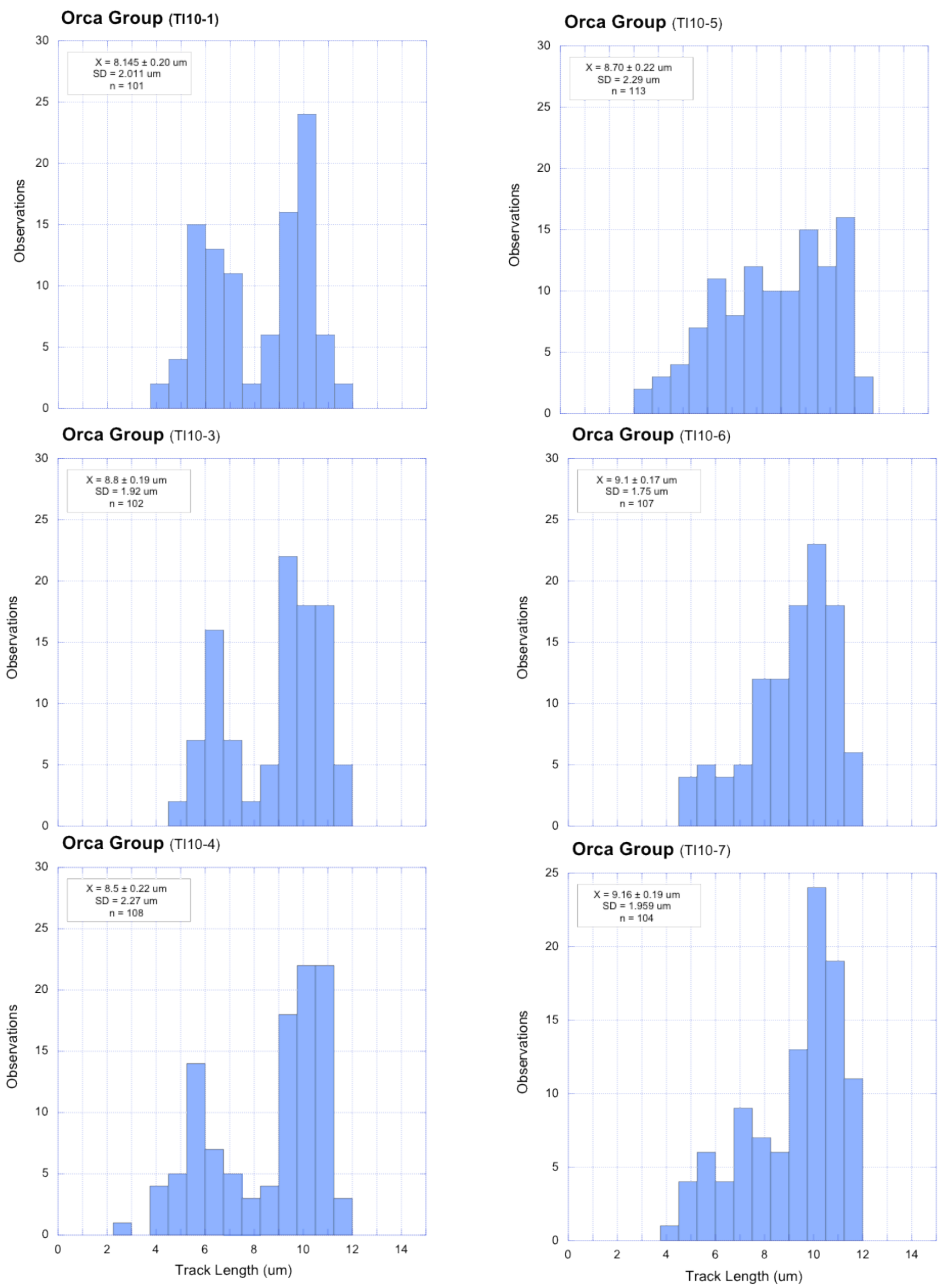

Figure 14. Track lengths for samples west of the Rude River fault (TI10-01, TI10-3, and TI10-04) on the left and samples east of the fault (TI10-05, TI10-06, and TI10-07) on the right.

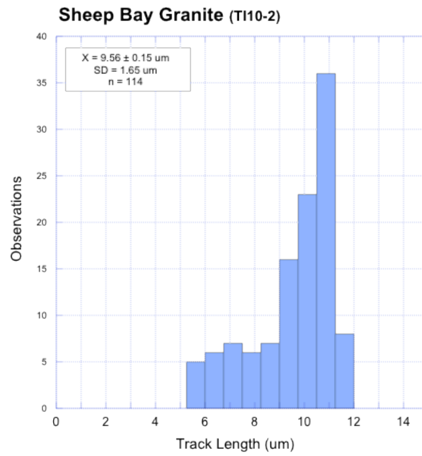

Figure 15. Track lengths for the Sheep Bay Granite (TI10-02).

Etch figure analysis. Etch figure measurements of grains from TI10-07 revealed mean figure lengths (MFL) ranging from 0.36 μm to 1.19 μm for all grains, and between 0.54 μm and 1.52 μm for the five largest measurements per grain, referred to as the mean maximum figure length (MMxFL) (see Appendix F). There is a strong positive correlation between MFL and MMxFL (R=0.88) (Figure 16). Mean maximum figure lengths correlate positively with uranium concentration (Figure 16) and negatively with the V_3SiO_4 data obtained from the micro-Raman spectroscopy (Figure 16). Mean figure length, when plotted versus standard deviation, reveals a predominant positive correlation that increases slightly in scatter with increasing MFL (Figure 16).

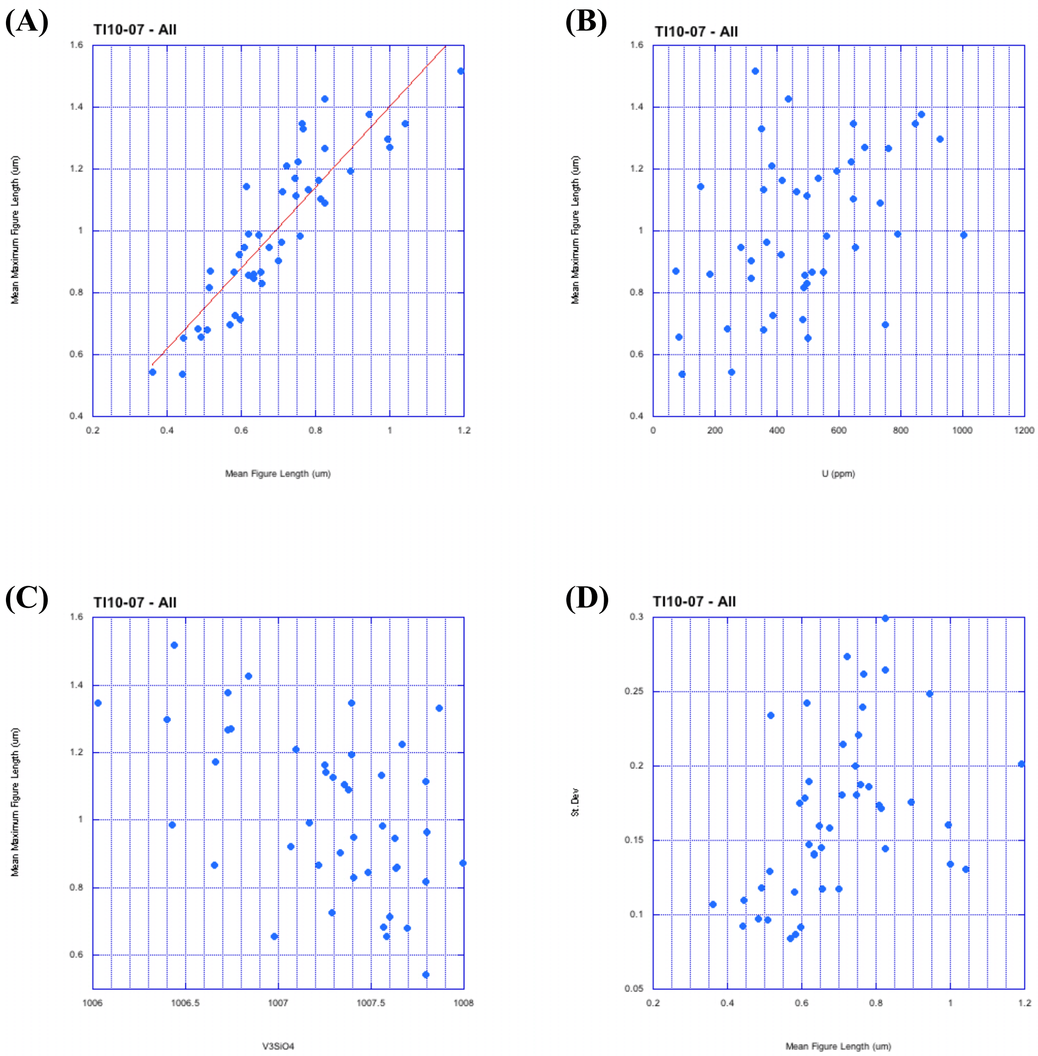

Figure 16. (A) Positive correlation between mean figure length (MFL) and mean maximum figure length (MMxFL) for sample TI10-07 as determined by etch figure analysis. Linear best-fit equation is y=0.095866 + 1.3035x and R=0.88742. (B) Mean maximum figure length versus uranium content for sample TI10-07. (C) Mean maximum figure length versus V_3SiO_4 peak data for sample TI10-07 determined by Raman spectroscopy revealing a negative relationship. (D) Mean figure length plotted against the standard deviation of mean figure length measurements for sample TI10-07.

Raman spectrometry. Raman spectrometry on 42 fission track-dated grains from TI10-07 show that the V_1SiO_4 peaks range from 973.02 to 974.52, while the V_3SiO_4 peaks range from 1006.03 to 1007.99 (see Appendix E). Two grains (TI10-07B82 and TI10-07B127) were lost prior to Raman analysis and therefore are not reflected in the data.

Peaks for V_1SiO_4 and V_3SiO_4 positively co-vary with a linear regression of 0.96 (Figure 17). The V_3SiO_4 peaks shift to lower wave numbers (to the left on the graph) with higher concentrations of uranium (Figure 17). Similarly, increasing MMxFL corresponds to the same leftward shift in the V_1SiO_4 and V_3SiO_4 peaks (Figure 17).

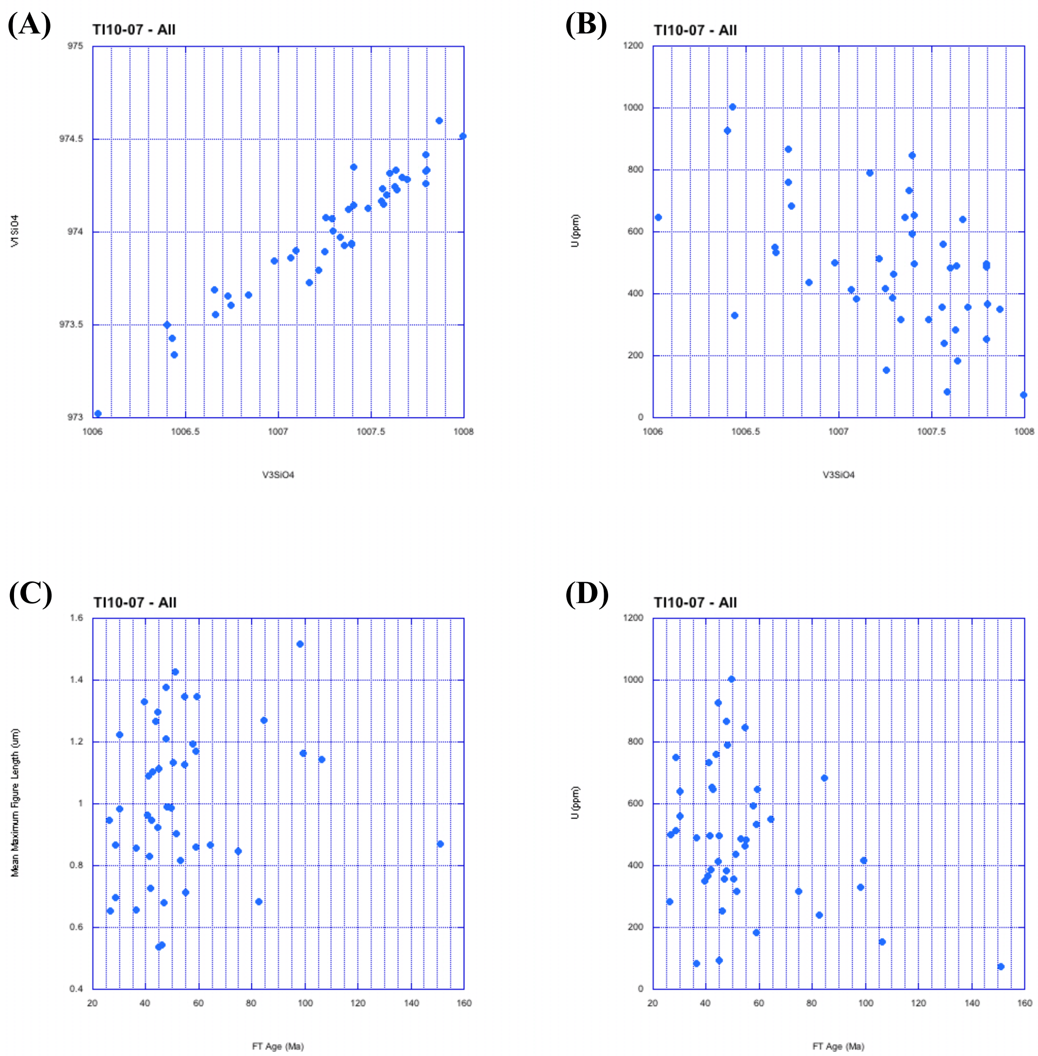

Figure 17. (A) Raman spectrometry analysis of TI10-07 revealing that V_1SiO_4 and V_3SiO_4 co-vary significantly, as would be expected. (B) V_3SiO_4 peak data plotted against uranium concentration for sample TI10-07 reveals a negative correlation. (C) Mean maximum figure length versus fission track age. The young reset grains have both narrow and wide figure lengths and, as such, MMxFL cannot be used as a proxy for low-retentive grains at this time. (D) Uranium concentration versus fission track age.

DISCUSSION

We interpret the Raman and mean figure length results as pertaining to compromising of the crystal structure of zircon by the uranium atom (and perhaps other impurities) and radiation damage (Marsellos and Garver, 2010). Uranium and other actinides substitute easily into the crystal structure of zircon. As uranium decays within the zircon grain, α-damage disrupts the crystal lattice and brings the grain closer to a glass-like or metamict state (Ewing, 1994). Therefore, higher uranium grains have higher radiation damage given similar increments of time and consequently weaker crystal structure. This relationship would in turn explain the co-variance of high uranium concentration with increased MFL and MMxFL measurements, as the KOH-NaOH eutectic etchant would likely etch the higher uranium grains with more radiation damage faster, producing larger etch figures. These grains may correlate to a lower degree of retention of fission tracks and may therefore be increasingly more susceptible to thermal annealing.

There is a high degree of variation in MMxFL for grains with young FT ages (Figure 17), which is in agreement with the variation seen between uranium and FT age (Figure 17) as uranium and MMxFL co-vary. All grains with uranium content greater than ~450 ppm have young FT ages, less than 80 Ma. The younger grains also have the highest variation in MMxFL, which supports the interpretation that higher uranium grains have further compromised crystal structures that subsequently etch faster. Results from Raman spectroscopy and the etch figure analysis suggest that there was no bias in the grains counted, and therefore reaffirm that the fission track ages determined are representative of the Orca Group in the Cordova area as a whole.

An objective of this study is to understand the time-temperature history of the Orca Group of the Prince William terrane with the overarching goal of understanding the tectonic evolution of the southern margin of Alaska. To understand the significance of these cooling ages, we must first look at the surrounding areas that have previously been studied. To the east of the present study site, the Chugach Metamorphic Complex (CMC) has a well-studied thermal evolution (Gasser et al., 2011). The unit has DZFT ages of

26.0 ± 2.8 Ma to 28.9 ± 2.4 Ma (Gasser et al., 2011). The three study sections of Gasser et al. (2011) have cooling histories that change slightly from west to east. The westernmost samples, which are closest to the Orca Group in this study, experienced ~15 Myr of slow cooling starting c. 50 Ma, followed by ~20-30 Myr of asynchronous cooling from c. 30 Ma to the present, with the eastern part of the study transect cooling more quickly than rocks to the south (Gasser et al., 2011). The geothermal gradient in the CMC has been estimate as ~35-65° C/km, elevated from 25° C/km, inferred to be the result of either the passage of a second triple junction or vertical thinning of a portion of the crust (Gasser et al., 2011; Sisson and Hollister, 1988; Sisson et al., 1989). The important thing to take away from the evolution of the CMC is the major thermal event at ~50 Ma and the alteration or variation of the geothermal gradient through time.

The flysch of the Chugach terrane, to the north, experienced a regional thermal event at ~48-52 Ma (Plafker et al., 1992). The thermal event resulted in widespread greenschist-facies metamorphism in the Chugach flysch and plutonism (Plafker et al., 1992), which likely altered the geothermal gradient as was observed in the CMC (Gasser et al., 2011). A slightly younger thermal event is well recorded in rocks to the west in northern Prince William Sound, where the Cedar Bay pluton and this family of granitic and gabbroic intrusions have K/Ar ages of 32.2 ± 1.6 Ma to 38.4 ± 1.9 Ma, suggesting intrusion at ~38-41 Ma and normal "uplift-related cooling" at ~32-38 Ma (Nelson et al., 1999).

Granodioritic and granitic plutons in western Prince William Sound, near Eshamy Bay have K/Ar ages of 34.4 to 36.6 Ma (Tysdal and Case, 1979). Orca Group samples from western Prince William Sound have young component populations of DZFT ranging from 36 to 45 Ma near Whale Bay on the Kenai Peninsula, 25 to 35 Ma on Bainbridge Island, and 31 to 36 Ma on Latouche Island (Kveton, 1989; see also Garver et al., 2010). Three granitic cobbles collected from Latouche Island have ZFT ages of 32.5 ± 2.1 Ma to 39.0 ± 2.2 Ma (Kveton, 1989). Vitrinite reflectance data, which is a widely used method for determining paleotemperatures, indicates that the Orca Group in western Prince William Sound experienced paleotemperatures at or greater than 250° C and possibly greater than 300° C (mean $\%R_o$ values of between 3.0 and 4.0%) (Kveton, 1989). The

duration that these rocks resided in this temperature range are unknown and thus, such is the degree of resetting of zircon grains; however, paleodepth estimates put the Orca Group at paleodepths between 8.3 and 17.5 km during peak heating (Kveton, 1989). The Paleocene Ghost Rocks on Kodiak Island, which may correlate with the Orca Group, have mean vitrinite reflectance values of 2.15-2.95%, indicating maximum paleotemperatures of 225-250 °C (see discussion in Kveton, 1989). Just outboard of the Whale, Bainbridge, and Latouche belts in western Prince William Sound, the Montague belt have significantly lower mean vitrinite reflectance values (0.8-1.1%). Based on these findings, we interpret the Orca Group of eastern Prince William Sound to have resided in the maximum paleotemperature range of 250 to 300 °C for an unknown duration.

In the present study, samples of the Orca Group have 2-3 grain-age populations common to several samples. Samples are discussed here as being either west or east of the Rude River fault, which extends from the mainland and bisects Orca Bay parallel with Hawkins Island (Figure 5). Samples TI10-01, TI10-03, and TI10-04 lay west of this fault, while samples TI10-05, TI10-06, and TI10-07 lay to the east. One key finding is that all samples have a grain-age population at ~49 Ma comprised of >50% of grains counted. Samples east of the fault have a younger population at ~31 Ma, comprised of 15-43% of grains counted. Sample TI10-04, which lies directly adjacent to the Rude River fault on the west and is therefore closest to the east samples, has a similar population within error at 23.1 ± 6.4 Ma. All samples share population at ~80 Ma and older, which may mean very little if it includes partly annealed grains, which seems likely. The Sheep Bay Granite has a K-Ar (biotite) age of 53.2 ± 1.6 Ma and K-Ar (hornblende) age of 50.5 ± 1.5 Ma (Winkler et al., 1981; Plafker et al., 1985; Nelson et al., 1985). The sample collected for this study shows overdispersion in the ZFT ages (i.e. it fails χ^2). It has a young component population of 28.0±2.4 Ma and a slightly older population at 39.7 ± 2.6 Ma.

The Contact fault separates the more outboard Prince William terrane from the more inboard Chugach terrane to the north. The main component of the Chugach terrane is the

flysch of the Campanian-Maastrichtian Valdez Group, which was recently studied using detrital zircon fission track techniques (Milde, 2011). Six samples of medium- to coarse-grained sandstones were collected along the Richardson Highway north of the city of Valdez. These samples underwent the same fission track, track length, raman spectroscopy, and figure length analyses as explained in the present study. These samples from the Valdez Group have a common young grain-age population of 37.7 ± 1.6 Ma, with three samples having an additional older population at 50.6 ± 4.0 Ma (Milde, 2011). Track lengths were primarily unimodal for the Valdez Group samples, with two bimodal samples. All of the samples appeared to have been fully reset, because virtually no grains have cooling ages older than depositional age (c. 65-75 Ma).

Given the proximity of the Valdez Group transect (Milde, 2011) to the Orca Group transect of this study, it is likely that the two units experienced similar thermal histories. As the Campanian-Maastrichtian Valdez Group lies farther inboard, these older strata must have entered the accretionary wedge slightly earlier than the more outboard Paleocene-Eocene Orca Group. This simple interpretation could explain the slightly older grain-age populations in the Valdez, where P1 and P2 precede their Orca Group counterparts by only a few million years (37.7 ± 1.6 Ma and 50.6 ± 4.0 Ma compared to 31.2 ± 1.5 Ma and 48.5 ± 7.4 Ma) (Milde, 2011), though they are basically within error of each other. In this scenario, the fission track ages are likely cooling ages associated with erosional exhumation and upward movement through the accretionary wedge.

The ZFT age populations may simply correspond with regional thermal events. The Orca Group and Valdez Group have very similar P2 populations that are within error, at ~49 and ~51 Ma (Early Eocene), respectively, which is the dominant grain-age population for both (see Milde, 2011; Izykowski, 2011, Izykowski et al., 2011). These ages could correspond to the regional thermal event at 48-52 Ma recognized by Plafker et al. (1992), which is associated with the larger scale Sanak-Baranof plutonism that affected 2200 km of the Alaska margin from 61-50 Ma (Plafker et al., 1994; Bradley et al., 2003; Cowan, 2003).

The middle Eocene age populations for both the Orca Group (31 Ma) and Valdez Group (38 Ma) could be associated with the slightly more recent plutonism studied in western Prince William Sound, where thermal events were noted at ~25-40 Ma (Kveton, 1989; Nelson et al., 1999).

The ZFT result for the Sheep Bay pluton is unusual. The two grain-age populations of the 54 Ma Sheep Bay Granite could also be tied to the distinct thermal events in western Prince William Sound. It is unusual for a granitic rock to give a ZFT age that is overdispersed and two populations may indicate that the Sheep Bay Granite has had a complicated thermal history. The older population at 40 Ma could be related to the plutonism that produced the Eshamy Bay Granite, Cedar Bay Granite, and their relatives in northwestern Prince William Sound at c. 38 Ma (Nelson et al., 1999). This plutonism has been inferred to reflect the subduction of another ridge, that of the hypothesized Eshamy Plate of Madsen (2006). The young population at 28 Ma reflects yet another increase in the geothermal gradient that may be the same event that produced the Miners Bay pluton at ~25 Ma (Nelson et al., 1999). Given the timing of this younger thermal event, we suggest that it may be an early signal of the onset of the Yakutat collision. The granitic to gabbroic intrusions of Tysdal and Case (1979) may also be a product of this more recent thermal event, differing only in the composition of the source rock.

CONCLUSION

This study aims to further our understanding of the tectonic evolution of the southern margin of Alaska by examining the time-temperature history of the Orca Group of the Prince William terrane. Six samples of sandstone and one sample of the Sheep Bay Granite were collected near Cordova, AK and analyzed using standard detrital zircon fission track methods.

Two primary age populations were determined for the Orca Group sandstones, with a common peak at ~49 Ma for all samples and a younger peak for the eastern-lying samples at ~31 Ma. The zircon from the Sheep Bay Granite are overdispersed and have

two primary age populations, with a majority population at 40 Ma and a younger population at 28 Ma. The over-dispersion of grain-age populations in the Sheep Bay Granite indicate a complicated thermal history, which is not surprising considering the sandstones of the Orca Group have grain-age populations younger than depositional age (c. 55-65 Ma).

The data collected from this study provide more tools that may be used to reconstruct the tectonic evolution of southern Alaska. There are currently several working hypotheses that attempt to explain this evolution of the southern margin including the single-ridge hypothesis that requires terrane transport (Cowan, 2003) and the dual-ridge hypotheses that require the subduction of addition plates (Haeussler et al., 2003; Madsen, 2006). These hypotheses require further investigation and/or reevaluation based on more recent data before a final conclusion can be made.

This study also aimed at better understanding the role that radiation damage plays in detrital zircon fission track analysis. We infer that higher uranium grains have a higher degree of radiation damage, resulting in a weakened crystal structure that is increasingly susceptible to thermal annealing and etching response. The analyses performed on sample TI10-07 are successful in providing preliminary data; however these avenues must be investigated further and performed on more samples to further understand the role of radiation damage in the fission track process.

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APPENDIX A:

Zeta Calibration Data

MEAN ZETA CALCULATION

TITLE: Orca Group - Cordova, Alaska
OPERATOR NAME: Tyler Izykowski
DATE: 10 November 2010 to 9 February 2011

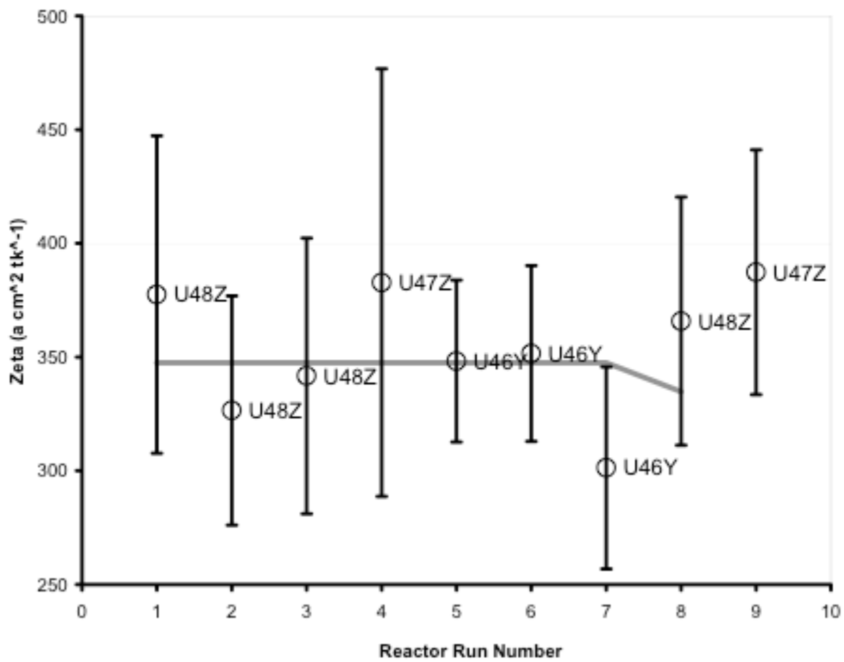
RESULTS

Weighted Mean Zeta =	**347.50**
±1SE =	**8.76**
±2SE =	**17.52**

DATA

Irradiation		Age Standard	Measured Zeta (a cm^2 tk^{-1})		
Run Name	**Position Number**	**Name**	**Zeta Value**	**Count SE**	**Total SE**
U48Z	25.0	BLK-1	377.5	34.9	35.2
U48Z	23.0	FCT-1	326.5	25.2	25.9
U48Z	21.0	FCT-2	341.7	30.3	30.7
U47Z	20.0	FCT-3	382.8	47.0	47.5
U46Y	31.0	FCT-4	348.2	17.8	18.9
U46Y	64.0	FCT-7	351.6	19.3	20.3
U46Y	65.0	PST-2	301.3	22.2	22.2
U48Z	20.0	PST2	365.8	27.3	27.4
U47Z	18.0	PST-3	387.3	26.9	27.0

MEAN ZETA CALCULATION - T. Izykowski (2011)



NOTE: This is the Excel replacement for ZetaMean (Mark Brandon, April, 2007). Individual zeta values are shown with 2SE error bars. The weighted mean zeta value is indicated by the horizontal gray line. Each data entry includes the zeta measurement plus two standard error estimates: the first represents only those uncertainties associated with the fission-track (FT) method (densities for spontaneous, induced, and fluence monitor), whereas the second includes the additional uncertainty associated with age of the age standard. The resulting mean zeta is calculated as a weighted average using count standard errors as weighting factors. (Count standard errors account for the collective uncertainties due to the measured induced, spontaneous, and monitor track densities.) In calculating the standard error, we first calculated a count-only standard error for the weighted mean and then Add the standard error due to the age standard. This procedure accounts for the fact that the uncertainty associated with the age of the standard is common to all zeta measurements.

=================Zfactor Program v. 1.2 (Brandon 3/18/95)=================
DATE/TIME: 03-01-2011/14:00:37 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\STANDA~1\BL1_48Z.FTZ
BLK-1, U48Z-25, IZYKOWSKI, 9 FEB 2011

AGE (MA) AND STANDARD ERROR (MY) OF AGE STANDARD: 16.40 0.20
TRACK DENSITY FOR GLASS STANDARD (TRACKS/CM^2): 3.451E+05
RELATIVE STANDARD ERROR FOR GLASS DENSITY (%): 1.52
SIZE OF COUNTING SQUARE (CM^2): 6.590E-07

------ ZETA FOR GRAINS OF AGE STANDARD ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	Zeta (yr cm^2)	Grain-only SE	Total SE
1	9.484E+05	(10)	5.785E+06	(61)	16	580.51	198.2	198.4
2	1.644E+06	(13)	8.852E+06	(70)	12	512.43	155.0	155.1
3	2.276E+06	(24)	4.078E+06	(43)	16	170.51	43.5	43.6
4	1.612E+06	(17)	7.113E+06	(75)	16	419.85	113.0	113.1
5	1.517E+06	(12)	6.070E+06	(48)	12	380.66	123.0	123.1
6	1.043E+06	(11)	5.406E+06	(57)	16	493.13	162.6	162.7
7	1.897E+06	(15)	5.943E+06	(47)	12	298.19	88.5	88.6
8	2.656E+06	(14)	1.062E+07	(56)	8	380.66	113.9	114.0
9	1.593E+06	(21)	6.980E+06	(92)	20	416.92	101.0	101.2
10	1.328E+06	(14)	4.742E+06	(50)	16	339.88	102.9	103.0
POOLED	1.591E+06	(151)	6.312E+06	(599)	144	377.51	34.9	35.2
MEAN ZETA (using grain ratios)						358.46	48.4	48.6

CHI-SQUARED PROBABILITY (%): 10.1

MEAN (RhoS/RhoI) +/- 1 SE: 0.265 +/- 0.0356

=================Zfactor Program v. 1.2 (Brandon 3/18/95)=================
DATE/TIME: 03-01-2011/14:01:03 FILENAME:
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FCT_1,U48Z-23, Izykowski

AGE (MA) AND STANDARD ERROR (MY) OF AGE STANDARD: 27.90 0.50
TRACK DENSITY FOR GLASS STANDARD (TRACKS/CM^2): 3.489E+05
RELATIVE STANDARD ERROR FOR GLASS DENSITY (%): 1.52
SIZE OF COUNTING SQUARE (CM^2): 6.590E-07

------ ZETA FOR GRAINS OF AGE STANDARD ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	Zeta (yr cm^2)	Grain-only SE	Total SE
1	6.576E+06	(65)	1.426E+07	(141)	15	347.68	52.4	52.8
2	5.785E+06	(61)	1.470E+07	(155)	16	407.26	61.9	62.3
3	6.373E+06	(63)	1.568E+07	(155)	15	394.33	59.2	59.6
4	6.222E+06	(82)	9.712E+06	(128)	20	250.19	35.6	35.9
5	5.690E+06	(60)	1.186E+07	(125)	16	333.91	52.7	53.0
6	3.642E+06	(36)	8.801E+06	(87)	15	387.34	77.0	77.3
7	5.564E+06	(66)	1.147E+07	(136)	18	330.27	49.8	50.2
8	6.829E+06	(90)	9.332E+06	(123)	20	219.05	30.6	30.8
9	6.154E+06	(73)	1.728E+07	(205)	18	450.10	61.7	62.3
10	5.463E+06	(54)	1.012E+07	(100)	15	296.81	50.3	50.6
POOLED	5.871E+06	(650)	1.224E+07	(1355)	168	334.12	16.7	17.8
MEAN ZETA (using grain ratios)						326.53	25.2	25.9

CHI-SQUARED PROBABILITY (%): 0.7

MEAN (RhoS/RhoI) +/- 1 SE: 0.491 +/- 0.0372

=================Zfactor Program v. 1.2 (Brandon 3/18/95)=================
DATE/TIME: 03-01-2011/14:00:01 FILENAME:
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FCT_2,U48Z-21, IZYKOWSKI, 12 NOV 2010

AGE (MA) AND STANDARD ERROR (MY) OF AGE STANDARD: 27.90 0.50
TRACK DENSITY FOR GLASS STANDARD (TRACKS/CM^2): 3.526E+05
RELATIVE STANDARD ERROR FOR GLASS DENSITY (%): 1.54
SIZE OF COUNTING SQUARE (CM^2): 6.590E-07

------ ZETA FOR GRAINS OF AGE STANDARD ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	Zeta (yr cm^2)	Grain-only SE	Total SE
1	4.552E+06	(60)	1.275E+07	(168)	20	444.07	67.1	67.6
2	6.491E+06	(77)	1.121E+07	(133)	18	273.94	39.5	39.8
3	3.187E+06	(42)	1.411E+07	(186)	20	702.35	120.5	121.1
4	4.932E+06	(65)	1.093E+07	(144)	20	351.35	52.8	53.2
5	4.856E+06	(64)	7.056E+06	(93)	20	230.46	37.6	37.8
6	4.856E+06	(64)	1.191E+07	(157)	20	389.06	58.0	58.4
7	4.780E+06	(63)	8.649E+06	(114)	20	286.98	45.3	45.6
8	2.360E+06	(28)	5.480E+06	(65)	18	368.17	83.4	83.7
9	9.105E+06	(108)	1.829E+07	(217)	18	318.66	37.8	38.3
10	9.200E+06	(97)	2.039E+07	(215)	16	351.53	43.3	43.8
POOLED	5.335E+06	(668)	1.192E+07	(1492)	190	354.23	17.4	18.5
MEAN ZETA (using grain ratios)						341.70	30.0	30.7

CHI-SQUARED PROBABILITY (%): 0.0

MEAN (RhoS/RhoI) +/- 1 SE: 0.464 +/- 0.0402

=================Zfactor Program v. 1.2 (Brandon 3/18/95)=================
DATE/TIME: 03-01-2011/14:01:28 FILENAME:
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FCT_3,U47Z-20, IZYKOWSKI, 21 SEPTEMBER 2010

AGE (MA) AND STANDARD ERROR (MY) OF AGE STANDARD: 27.90 0.50
TRACK DENSITY FOR GLASS STANDARD (TRACKS/CM^2): 3.330E+05
RELATIVE STANDARD ERROR FOR GLASS DENSITY (%): 2.00
SIZE OF COUNTING SQUARE (CM^2): 6.590E-07

------ ZETA FOR GRAINS OF AGE STANDARD ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	Zeta (yr cm^2)	Grain-only SE	Total SE
1	5.690E+06	(75)	1.457E+07	(192)	20	429.90	59.2	59.7
2	6.146E+06	(81)	1.328E+07	(175)	20	362.81	49.3	49.7
3	5.766E+06	(57)	7.183E+06	(71)	15	209.18	37.4	37.6
4	5.480E+06	(65)	1.281E+07	(152)	18	392.70	58.7	59.1
5	3.440E+06	(34)	1.204E+07	(119)	15	587.76	114.9	115.4
6	2.086E+06	(22)	8.156E+06	(86)	16	656.46	157.4	157.8
7	4.932E+06	(65)	1.358E+07	(179)	20	462.46	67.6	68.1
8	4.704E+06	(62)	1.047E+07	(138)	20	373.78	57.6	58.0
9	3.642E+06	(48)	7.132E+06	(94)	20	328.86	58.7	59.0
POOLED	4.710E+06	(509)	1.116E+07	(1206)	164	397.89	22.5	23.6
MEAN ZETA (using grain ratios)						382.77	47.0	47.5

CHI-SQUARED PROBABILITY (%): 0.1

MEAN (RhoS/RhoI) +/- 1 SE: 0.439 +/- 0.0532

=================Zfactor Program v. 1.2 (Brandon 3/18/95)=================
DATE/TIME: 03-01-2011/14:01:50 FILENAME:
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FCT_4,U46Y-31, IZYKOWSKI, 12 NOV 2010

AGE (MA) AND STANDARD ERROR (MY) OF AGE STANDARD: 27.90 0.50
TRACK DENSITY FOR GLASS STANDARD (TRACKS/CM^2): 3.278E+05
RELATIVE STANDARD ERROR FOR GLASS DENSITY (%): 1.61
SIZE OF COUNTING SQUARE (CM^2): 6.590E-07

------ ZETA FOR GRAINS OF AGE STANDARD ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	Zeta (yr cm^2)	Grain-only SE	Total SE
1	1.593E+06	(21)	1.973E+06	(26)	20	211.21	62.1	62.2
2	3.035E+06	(40)	8.346E+06	(110)	20	469.14	86.9	87.4
3	4.480E+06	(62)	7.660E+06	(106)	21	291.66	46.9	47.2
4	7.370E+06	(102)	1.351E+07	(187)	21	312.76	38.8	39.2
5	7.208E+06	(95)	1.525E+07	(201)	20	360.94	45.3	45.8
6	4.647E+06	(49)	9.579E+06	(101)	16	351.63	61.5	61.8
7	3.794E+06	(50)	8.574E+06	(113)	20	385.54	65.8	66.1
8	5.275E+06	(73)	1.156E+07	(160)	21	373.91	53.2	53.6
9	5.008E+06	(66)	9.105E+06	(120)	20	310.17	47.8	48.1
10	5.690E+06	(75)	1.275E+07	(168)	20	382.13	53.4	53.9
POOLED	4.827E+06	(633)	9.852E+06	(1292)	199	348.20	17.8	18.9
MEAN ZETA (using grain ratios)						330.95	25.1	25.8

CHI-SQUARED PROBABILITY (%): 41.0

MEAN (RhoS/RhoI) +/- 1 SE: 0.515 +/- 0.0383

=================Zfactor Program v. 1.2 (Brandon 3/18/95)=================
DATE/TIME: 03-01-2011/14:02:06 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\STANDA~1\FC7_46Y.FTZ
FCT_7,U46Y-64, IZYKOWSKI, 12 NOV 2010

AGE (MA) AND STANDARD ERROR (MY) OF AGE STANDARD: 27.90 0.50
TRACK DENSITY FOR GLASS STANDARD (TRACKS/CM^2): 2.846E+05
RELATIVE STANDARD ERROR FOR GLASS DENSITY (%): 2.14
SIZE OF COUNTING SQUARE (CM^2): 6.590E-07

------ ZETA FOR GRAINS OF AGE STANDARD ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	Zeta (yr cm^2)	Grain-only SE	Total SE
1	6.702E+06	(53)	1.239E+07	(98)	12	363.32	62.4	62.8
2	4.780E+06	(63)	1.077E+07	(142)	20	442.88	67.7	68.2
3	4.932E+06	(39)	7.461E+06	(59)	12	297.25	61.7	61.9
4	4.047E+06	(56)	6.792E+06	(94)	21	329.82	56.1	56.4
5	5.058E+06	(70)	9.249E+06	(128)	21	359.30	54.0	54.3
6	5.311E+06	(56)	1.005E+07	(106)	16	371.93	62.0	62.3
7	5.785E+06	(61)	1.043E+07	(110)	16	354.33	57.1	57.4
8	5.311E+06	(56)	8.346E+06	(88)	16	308.77	53.2	53.5
9	6.601E+06	(87)	1.085E+07	(143)	20	322.97	44.5	44.8
10	6.734E+06	(71)	1.204E+07	(127)	16	351.47	52.6	53.0
POOLED	5.463E+06	(612)	9.774E+06	(1095)	170	351.56	19.3	20.3
MEAN ZETA (using grain ratios)						346.25	14.0	15.3

CHI-SQUARED PROBABILITY (%): 89.2

MEAN (RhoS/RhoI) +/- 1 SE: 0.567 +/- 0.0195

=================Zfactor Program v. 1.2 (Brandon 3/18/95)=================
DATE/TIME: 03-01-2011/14:02:27 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\STANDA~1\PS2_46Y.FTZ
PST_2,U46Y_65, IZYKOWSKI, 12 NOV 2010

AGE (MA) AND STANDARD ERROR (MY) OF AGE STANDARD: 18.51 0.10
TRACK DENSITY FOR GLASS STANDARD (TRACKS/CM^2): 2.833E+05
RELATIVE STANDARD ERROR FOR GLASS DENSITY (%): 2.19
SIZE OF COUNTING SQUARE (CM^2): 6.590E-07

------ ZETA FOR GRAINS OF AGE STANDARD ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	Zeta (yr cm^2)	Grain-only SE	Total SE
1	3.414E+06	(36)	9.200E+06	(97)	16	352.60	69.2	69.3
2	3.130E+06	(33)	5.406E+06	(57)	16	226.03	49.7	49.7
3	4.647E+06	(49)	9.579E+06	(101)	16	269.74	47.3	47.4
4	2.561E+06	(27)	5.121E+06	(54)	16	261.72	62.0	62.0
5	2.276E+06	(18)	6.576E+06	(52)	12	378.05	103.7	103.7
6	1.802E+06	(19)	6.354E+06	(67)	16	461.46	120.4	120.4
7	2.750E+06	(29)	5.501E+06	(58)	16	261.72	59.8	59.8
8	4.805E+06	(38)	9.990E+06	(79)	12	272.06	54.0	54.1
9	3.983E+06	(42)	9.958E+06	(105)	16	327.15	60.2	60.2
POOLED	3.247E+06	(291)	7.476E+06	(670)	136	301.30	22.2	22.2
MEAN ZETA (using grain ratios)						298.47	22.2	22.2

CHI-SQUARED PROBABILITY (%): 49.1

MEAN (RhoS/RhoI) +/- 1 SE: 0.438 +/- 0.0311

=================Zfactor Program v. 1.2 (Brandon 3/18/95)=================
DATE/TIME: 03-01-2011/14:02:39 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\STANDA~1\PS2_48Z.FTZ
PST_2,U48Z_20, Izykowski, 9 FEB 2011

AGE (MA) AND STANDARD ERROR (MY) OF AGE STANDARD: 18.51 0.10
TRACK DENSITY FOR GLASS STANDARD (TRACKS/CM^2): 3.545E+05
RELATIVE STANDARD ERROR FOR GLASS DENSITY (%): 1.55
SIZE OF COUNTING SQUARE (CM^2): 6.590E-07

------ ZETA FOR GRAINS OF AGE STANDARD ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	Zeta (yr cm^2)	Grain-only SE	Total SE
1	3.319E+06	(35)	1.309E+07	(138)	16	412.34	78.3	78.3
2	1.423E+06	(15)	6.829E+06	(72)	16	501.98	142.7	142.7
3	1.707E+06	(18)	8.536E+06	(90)	16	522.89	135.3	135.3
4	2.086E+06	(22)	7.967E+06	(84)	16	399.30	95.8	95.9
5	1.707E+06	(18)	5.785E+06	(61)	16	354.41	95.2	95.2
6	9.105E+05	(12)	2.200E+06	(29)	20	252.73	86.8	86.8
7	2.750E+06	(29)	9.579E+06	(101)	16	364.22	76.9	77.0
8	2.200E+06	(29)	7.436E+06	(98)	20	353.40	74.9	74.9
9	3.983E+06	(42)	9.769E+06	(103)	16	256.47	47.1	47.1
10	3.541E+06	(21)	1.130E+07	(67)	9	333.66	83.6	83.6
POOLED	2.271E+06	(241)	7.945E+06	(843)	161	365.81	27.3	27.4
MEAN ZETA (using grain ratios)						356.08	28.1	28.2

CHI-SQUARED PROBABILITY (%): 44.9

MEAN (RhoS/RhoI) +/- 1 SE: 0.294 +/- 0.0227

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=================Zfactor Program  v. 1.2  (Brandon 3/18/95)=================
DATE/TIME: 03-01-2011/14:02:53  FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\STANDA~1\PS3_47Z.FTZ
PST_3,U47Z_18, IZYKOWSKI, 9 FEB 2011

AGE (MA) AND STANDARD ERROR (MY) OF AGE STANDARD:   18.51     0.10
  TRACK DENSITY FOR GLASS STANDARD (TRACKS/CM^2):    3.379E+05
   RELATIVE STANDARD ERROR FOR GLASS DENSITY (%):    1.81
                  SIZE OF COUNTING SQUARE (CM^2):    6.590E-07

------ ZETA FOR GRAINS OF AGE STANDARD ------
Grain    RhoS     (Ns)    RhoI      (Ni)  Squares   Zeta  Grain-only  Total
 no.   (cm^-2)           (cm^-2)                  (yr cm^2)    SE        SE
   1   2.656E+06 ( 35)   9.863E+06 (130)     20     407.52    78.0     78.0
   2   1.897E+06 ( 20)   9.105E+06 ( 96)     16     526.64   129.8    129.8
   3   1.233E+06 ( 13)   6.734E+06 ( 71)     16     599.22   181.1    181.1
   4   2.360E+06 ( 14)   7.081E+06 ( 42)      9     329.15   101.8    101.8
   5   4.249E+06 ( 56)   1.275E+07 (168)     20     329.15    51.1     51.2
   6   2.959E+06 ( 39)   9.712E+06 (128)     20     360.10    66.2     66.2
   7   1.802E+06 ( 19)   7.777E+06 ( 82)     16     473.51   120.9    120.9
   8   2.845E+06 ( 30)   8.346E+06 ( 88)     16     321.84    68.3     68.3
   9   2.940E+06 ( 31)   1.072E+07 (113)     16     399.93    81.4     81.4
  10   2.124E+06 ( 28)   6.677E+06 ( 88)     20     344.82    75.1     75.1

POOLED 2.559E+06( 285)   9.033E+06(1006)    169     387.28    26.9     27.0
MEAN ZETA (using grain ratios)                      392.24    25.9     26.0

CHI-SQUARED PROBABILITY (%):   63.4

MEAN (RhoS/RhoI) +/- 1 SE:      0.280  +/-  0.0178
```

APPENDIX B:

Fluence Data

=================Fluence Program v. 1.1 (Brandon 7/6/97)=================
DATE/TIME: 11-19-2010/15:05:15
U46Y IZYKOWSKI 19 NOV 2010

=========INTERPOLATED TRACK DENSITY USING A PAIR OF GLASS STANDARDS=========

----------POSITION IN PACKAGE--------			----EFFECTIVE VALUES AT POSITION----		
Monitor Label	Position	Distance(%)	Nd	RhoD (t/cm^2)	RE[RhoD](%)
FIRST MONITOR:	1	0.0	2015	3.670E+05	2.23
	2	1.5	2015	3.657E+05	2.20
	3	3.1	2015	3.644E+05	2.18
	4	4.6	2015	3.631E+05	2.15
	5	6.2	2015	3.618E+05	2.12
	6	7.7	2014	3.605E+05	2.10
	7	9.2	2014	3.592E+05	2.07
	8	10.8	2014	3.578E+05	2.05
	9	12.3	2014	3.565E+05	2.02
	10	13.8	2014	3.552E+05	2.00
	11	15.4	2014	3.539E+05	1.97
	12	16.9	2014	3.526E+05	1.95
	13	18.5	2014	3.513E+05	1.93
	14	20.0	2014	3.500E+05	1.90
	15	21.5	2013	3.487E+05	1.88
	16	23.1	2013	3.474E+05	1.86
	17	24.6	2013	3.461E+05	1.84
	18	26.2	2013	3.448E+05	1.82
	19	27.7	2013	3.435E+05	1.79
	20	29.2	2013	3.422E+05	1.77
	21	30.8	2013	3.408E+05	1.76
	22	32.3	2013	3.395E+05	1.74
	23	33.8	2013	3.382E+05	1.72
	24	35.4	2013	3.369E+05	1.70
	25	36.9	2012	3.356E+05	1.69
	26	38.5	2012	3.343E+05	1.67
	27	40.0	2012	3.330E+05	1.66
	28	41.5	2012	3.317E+05	1.64
	29	43.1	2012	3.304E+05	1.63
	30	44.6	2012	3.291E+05	1.62
	31	46.2	2012	3.278E+05	1.61
	32	47.7	2012	3.265E+05	1.60
	33	49.2	2012	3.252E+05	1.59
	34	50.8	2011	3.238E+05	1.59
	35	52.3	2011	3.225E+05	1.58
	36	53.8	2011	3.212E+05	1.58
	37	55.4	2011	3.199E+05	1.58
	38	56.9	2011	3.186E+05	1.58
	39	58.5	2011	3.173E+05	1.58
	40	60.0	2011	3.160E+05	1.58
	41	61.5	2011	3.147E+05	1.59
	42	63.1	2011	3.134E+05	1.59
	43	64.6	2010	3.121E+05	1.60
	44	66.2	2010	3.108E+05	1.61
	45	67.7	2010	3.095E+05	1.62
	46	69.2	2010	3.082E+05	1.63
	47	70.8	2010	3.068E+05	1.65
	48	72.3	2010	3.055E+05	1.66
	49	73.8	2010	3.042E+05	1.68

=================Fluence Program v. 1.1 (Brandon 7/6/97)=================
DATE/TIME: 11-19-2010/15:05:15
U46Y IZYKOWSKI 19 NOV 2010

=========INTERPOLATED TRACK DENSITY USING A PAIR OF GLASS STANDARDS=========

----------POSITION IN PACKAGE--------			----EFFECTIVE VALUES AT POSITION----		
Monitor Label	Position	Distance(%)	Nd	RhoD (t/cm^2)	RE[RhoD](%)
	50	75.4	2010	3.029E+05	1.70
	51	76.9	2010	3.016E+05	1.72
	52	78.5	2010	3.003E+05	1.75
	53	80.0	2009	2.990E+05	1.77
	54	81.5	2009	2.977E+05	1.80
	55	83.1	2009	2.964E+05	1.82
	56	84.6	2009	2.951E+05	1.85
	57	86.2	2009	2.938E+05	1.89
	58	87.7	2009	2.925E+05	1.92
	59	89.2	2009	2.912E+05	1.95
	60	90.8	2009	2.898E+05	1.99
	61	92.3	2009	2.885E+05	2.03
	62	93.8	2008	2.872E+05	2.06
	63	95.4	2008	2.859E+05	2.10
	64	96.9	2008	2.846E+05	2.14
	65	98.5	2008	2.833E+05	2.19
SECOND MONITOR:	66	100.0	2008	2.820E+05	2.23

=================Fluence Program v. 1.1 (Brandon 7/6/97)=================
DATE/TIME: 10-29-2010/16:48:43
U47Z FLUENCE IZYKOWSKI 18 AUGUST 2010

=========INTERPOLATED TRACK DENSITY USING A PAIR OF GLASS STANDARDS=========

----------POSITION IN PACKAGE--------			----EFFECTIVE VALUES AT POSITION----		
Monitor Label	Position	Distance(%)	Nd	RhoD (t/cm^2)	RE[RhoD](%)
FIRST MONITOR:	1	0.0	2015	3.800E+05	2.23
	2	4.8	2015	3.775E+05	2.14
	3	9.5	2015	3.750E+05	2.05
	4	14.3	2015	3.726E+05	1.97
	5	19.0	2016	3.701E+05	1.89
	6	23.8	2016	3.676E+05	1.82
	7	28.6	2016	3.651E+05	1.75
	8	33.3	2016	3.627E+05	1.69
	9	38.1	2016	3.602E+05	1.65
	10	42.9	2016	3.577E+05	1.61
	11	47.6	2016	3.552E+05	1.59
	12	52.4	2017	3.528E+05	1.58
	13	57.1	2017	3.503E+05	1.58
	14	61.9	2017	3.478E+05	1.60
	15	66.7	2017	3.453E+05	1.63
	16	71.4	2017	3.429E+05	1.68
	17	76.2	2017	3.404E+05	1.74
	18	81.0	2017	3.379E+05	1.81
	19	85.7	2018	3.354E+05	1.90
	20	90.5	2018	3.330E+05	2.00
	21	95.2	2018	3.305E+05	2.11
SECOND MONITOR:	22	100.0	2018	3.280E+05	2.23

=================Fluence Program v. 1.1 (Brandon 7/6/97)=================
DATE/TIME: 11-12-2010/14:39:48
U48Z_IZYKOWSKI_12NOV2010

=========INTERPOLATED TRACK DENSITY USING A PAIR OF GLASS STANDARDS=========

----------POSITION IN PACKAGE--------			----EFFECTIVE VALUES AT POSITION----		
Monitor Label	Position	Distance(%)	Nd	RhoD (t/cm^2)	RE[RhoD](%)
FIRST MONITOR:	1	0.0	2345	3.900E+05	2.07
	2	2.2	2338	3.881E+05	2.03
	3	4.3	2330	3.863E+05	2.00
	4	6.5	2323	3.844E+05	1.96
	5	8.7	2316	3.825E+05	1.93
	6	10.9	2308	3.807E+05	1.90
	7	13.0	2301	3.788E+05	1.86
	8	15.2	2294	3.769E+05	1.83
	9	17.4	2287	3.750E+05	1.80
	10	19.6	2279	3.732E+05	1.77
	11	21.7	2272	3.713E+05	1.74
	12	23.9	2265	3.694E+05	1.72
	13	26.1	2257	3.676E+05	1.69
	14	28.3	2250	3.657E+05	1.66
	15	30.4	2243	3.638E+05	1.64
	16	32.6	2235	3.620E+05	1.62
	17	34.8	2228	3.601E+05	1.60
	18	37.0	2221	3.582E+05	1.58
	19	39.1	2214	3.563E+05	1.56
	20	41.3	2206	3.545E+05	1.55
	21	43.5	2199	3.526E+05	1.54
	22	45.7	2192	3.507E+05	1.53
	23	47.8	2184	3.489E+05	1.52
	24	50.0	2177	3.470E+05	1.52
	25	52.2	2170	3.451E+05	1.52
	26	54.3	2162	3.433E+05	1.52
	27	56.5	2155	3.414E+05	1.52
	28	58.7	2148	3.395E+05	1.53
	29	60.9	2140	3.377E+05	1.54
	30	63.0	2133	3.358E+05	1.55
	31	65.2	2126	3.339E+05	1.57
	32	67.4	2119	3.320E+05	1.59
	33	69.6	2111	3.302E+05	1.61
	34	71.7	2104	3.283E+05	1.64
	35	73.9	2097	3.264E+05	1.67
	36	76.1	2089	3.246E+05	1.70
	37	78.3	2082	3.227E+05	1.73
	38	80.4	2075	3.208E+05	1.77
	39	82.6	2067	3.190E+05	1.81
	40	84.8	2060	3.171E+05	1.85
	41	87.0	2053	3.152E+05	1.90
	42	89.1	2046	3.133E+05	1.95
	43	91.3	2038	3.115E+05	2.00
	44	93.5	2031	3.096E+05	2.05
	45	95.7	2024	3.077E+05	2.11
	46	97.8	2016	3.059E+05	2.17
SECOND MONITOR:	47	100.0	2009	3.040E+05	2.23

APPENDIX C:

Grain Age Data and Sample Location Notes

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================

TI10-01: Orca Group Conglomerate
Location: Sheep Point
GPS: N 60° 37.292′, W 146° 00.698′ SL
Etch Times: 24.5, 23.0, 20.5 hr
- Interbedded medium- to thin- mudstone with shale and dominant massive conglomerate. Conglomerate is cobble to pebble with rounded clasts of predominantly sedimentary rocks and few silicic volcanic and granite clasts.

DATE/TIME: 03-01-2011/14:23:06 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-01.FTZ
TI10-01A,B,C Orca Group - FEB 2011

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>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2):      3.433E+05
                                       RELATIVE ERROR (%):      1.52
               EFFECTIVE URANIUM CONTENT OF MONITOR (ppm):     12.30
                 ZETA FACTOR AND STANDARD ERROR (yr cm^2):    347.50     8.76
                            SIZE OF COUNTER SQUARE (cm^2):      6.590E-07
------ GRAIN AGES IN ORIGINAL ORDER ------
```

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	
1	1.79E+07	(106)	1.52E+07	(90)	9	544	115	69.8	52.5	92.8
2	1.97E+07	(78)	9.61E+06	(38)	6	344	111	121.0	81.4	183.1
3	4.25E+06	(28)	7.28E+06	(48)	10	261	75	34.8	21.0	56.4
4	7.59E+06	(40)	1.01E+07	(53)	8	360	99	44.9	29.0	68.9
5	7.78E+06	(41)	7.02E+06	(37)	8	251	82	65.7	41.2	105.3
6	8.92E+06	(47)	1.38E+07	(73)	8	496	117	38.3	26.0	56.0
7	1.46E+07	(77)	1.04E+07	(55)	8	374	101	82.9	58.0	119.3
8	5.31E+06	(28)	8.35E+06	(44)	8	299	90	37.9	22.7	62.1
9	2.16E+07	(57)	2.43E+07	(64)	4	870	218	52.9	36.4	76.8
10	9.86E+06	(39)	1.19E+07	(47)	6	426	124	49.3	31.4	77.0
11	1.02E+07	(54)	1.19E+07	(63)	8	428	108	51.0	34.7	74.4
12	1.37E+07	(54)	1.67E+07	(66)	6	598	148	48.6	33.3	70.7
13	1.14E+07	(60)	1.21E+07	(64)	8	435	109	55.7	38.5	80.4
14	1.35E+07	(71)	1.23E+07	(65)	8	442	110	64.8	45.7	92.1
15	6.64E+06	(35)	5.88E+06	(31)	8	211	75	67.0	40.2	112.1

```
>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2):      3.414E+05
                                       RELATIVE ERROR (%):      1.52
               EFFECTIVE URANIUM CONTENT OF MONITOR (ppm):     12.30
                 ZETA FACTOR AND STANDARD ERROR (yr cm^2):    347.50     8.76
                            SIZE OF COUNTER SQUARE (cm^2):      6.590E-07
------ GRAIN AGES IN ORIGINAL ORDER ------
```

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	
16	1.39E+07	(55)	9.36E+06	(37)	6	337	111	87.5	56.8	136.3
17	1.39E+07	(55)	2.12E+07	(84)	6	765	168	38.8	27.0	55.1
18	1.59E+07	(63)	1.37E+07	(54)	6	492	134	68.8	47.1	100.8
19	9.10E+06	(48)	8.54E+06	(45)	8	308	92	63.0	41.1	96.6
20	1.16E+07	(46)	1.49E+07	(59)	6	538	140	46.1	30.6	68.9
21	8.16E+06	(43)	9.86E+06	(52)	8	355	99	48.9	31.9	74.6
22	5.31E+06	(28)	3.60E+06	(19)	8	130	59	86.6	46.9	163.7
23	1.14E+07	(30)	1.21E+07	(32)	4	437	154	55.4	32.5	93.9
24	3.98E+06	(21)	8.35E+06	(44)	8	301	91	28.4	16.0	48.5
25	2.85E+06	(15)	3.22E+06	(17)	8	116	56	52.2	24.3	110.5
26	4.55E+06	(24)	4.55E+06	(24)	8	164	66	59.1	32.2	108.3
27	9.10E+06	(48)	1.02E+07	(54)	8	369	101	52.5	34.8	78.9
28	9.86E+06	(26)	1.06E+07	(28)	4	383	144	54.9	30.9	96.8
29	7.40E+06	(39)	9.48E+06	(50)	8	342	97	46.1	29.5	71.5
30	9.10E+06	(36)	1.06E+07	(42)	6	383	118	50.7	31.5	80.9

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================

DATE/TIME: 03-01-2011/14:23:06 FILENAME:

C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-01.FTZ

TI10-01A,B,C Orca Group - FEB 2011

>>NEW PARAMETERS--ZETA METHOD<<

EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2):	3.395E+05
RELATIVE ERROR (%):	1.53
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm):	12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2):	347.50 8.76
SIZE OF COUNTER SQUARE (cm^2):	6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	
31	4.55E+06	(24)	5.88E+06	(31)	8	213	76	45.6	25.6	80.0
32	3.41E+06	(18)	6.83E+06	(36)	8	247	82	29.6	15.7	53.2
33	1.56E+07	(41)	1.97E+07	(52)	4	715	198	46.4	30.0	71.1
34	5.06E+06	(20)	7.84E+06	(31)	6	284	102	38.1	20.5	68.6
35	4.55E+06	(18)	7.08E+06	(28)	6	257	96	37.9	19.7	70.7
36	7.08E+06	(28)	1.09E+07	(43)	6	394	120	38.4	22.9	63.0

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================

DATE/TIME: 03-01-2011/14:23:06 FILENAME:

C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-01.FTZ

TI10-01A,B,C Orca Group - FEB 2011

Number of grains = 36

------ GRAIN AGES ORDERED WITH INCREASING AGE ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Grain age (Ma) Age	--95% CI--		P(X2) (%)	Sum age (Ma) Age	--95% CI--	
24	3.98E+06	(21)	8.35E+06	(44)	28.4	16.0	48.5	100.0	28.5	16.0	48.8
32	3.41E+06	(18)	6.83E+06	(36)	29.6	15.7	53.2	91.7	28.7	19.0	42.5
3	4.25E+06	(28)	7.28E+06	(48)	34.8	21.0	56.4	82.6	30.9	22.6	41.9
8	5.31E+06	(28)	8.35E+06	(44)	37.9	22.7	62.1	83.2	32.8	25.4	42.4
35	4.55E+06	(18)	7.08E+06	(28)	37.9	19.7	70.7	90.0	33.5	26.5	42.5
34	5.06E+06	(20)	7.84E+06	(31)	38.1	20.5	68.6	94.3	34.1	27.4	42.5
6	8.92E+06	(47)	1.38E+07	(73)	38.3	26.0	56.0	95.9	35.1	29.0	42.6
36	7.08E+06	(28)	1.09E+07	(43)	38.4	22.9	63.0	97.8	35.5	29.6	42.5
17	1.39E+07	(55)	2.12E+07	(84)	38.8	27.0	55.1	98.6	36.1	30.7	42.5
4	7.59E+06	(40)	1.01E+07	(53)	44.9	29.0	68.9	97.3	37.1	31.8	43.3
31	4.55E+06	(24)	5.88E+06	(31)	45.6	25.6	80.0	97.4	37.6	32.4	43.7
20	1.16E+07	(46)	1.49E+07	(59)	46.1	30.6	68.9	96.3	38.5	33.4	44.3
29	7.40E+06	(39)	9.48E+06	(50)	46.1	29.5	71.5	96.2	39.1	34.1	44.8
33	1.56E+07	(41)	1.97E+07	(52)	46.4	30.0	71.1	96.3	39.6	34.7	45.2
12	1.37E+07	(54)	1.67E+07	(66)	48.6	33.3	70.7	94.9	40.4	35.6	45.9
21	8.16E+06	(43)	9.86E+06	(52)	48.9	31.9	74.6	94.6	41.0	36.3	46.3
10	9.86E+06	(39)	1.19E+07	(47)	49.3	31.4	77.0	94.7	41.5	36.8	46.7
30	9.10E+06	(36)	1.06E+07	(42)	50.7	31.5	80.9	94.7	41.9	37.3	47.1
11	1.02E+07	(54)	1.19E+07	(63)	51.0	34.7	74.4	93.8	42.5	37.9	47.6
25	2.85E+06	(15)	3.22E+06	(17)	52.2	24.3	110.5	95.0	42.7	38.1	47.8
27	9.10E+06	(48)	1.02E+07	(54)	52.5	34.8	78.9	94.2	43.2	38.7	48.2
9	2.16E+07	(57)	2.43E+07	(64)	52.9	36.4	76.8	93.1	43.8	39.3	48.7
28	9.86E+06	(26)	1.06E+07	(28)	54.9	30.9	96.8	93.4	44.0	39.6	49.0
23	1.14E+07	(30)	1.21E+07	(32)	55.4	32.5	93.9	93.3	44.4	39.9	49.3
13	1.14E+07	(60)	1.21E+07	(64)	55.7	38.5	80.4	91.3	45.0	40.5	49.8
26	4.55E+06	(24)	4.55E+06	(24)	59.1	32.2	108.3	91.0	45.2	40.8	50.1
19	9.10E+06	(48)	8.54E+06	(45)	63.0	41.1	96.6	85.3	45.9	41.5	50.7
14	1.35E+07	(71)	1.23E+07	(65)	64.8	45.7	92.1	71.4	46.8	42.4	51.6
5	7.78E+06	(41)	7.02E+06	(37)	65.7	41.2	105.3	64.7	47.3	42.9	52.1
15	6.64E+06	(35)	5.88E+06	(31)	67.0	40.2	112.1	59.3	47.7	43.3	52.6
18	1.59E+07	(63)	1.37E+07	(54)	68.8	47.1	100.8	44.7	48.5	44.1	53.3
1	1.79E+07	(106)	1.52E+07	(90)	69.8	52.5	92.8	23.0	49.7	45.3	54.6
7	1.46E+07	(77)	1.04E+07	(55)	82.9	58.0	119.3	6.8	50.9	46.4	55.8

```
 22  5.31E+06 (  28) 3.60E+06 (  19)  86.6  46.9 163.7   4.5   51.3  46.8  56.2
 16  1.39E+07 (  55) 9.36E+06 (  37)  87.5  56.8 136.3   1.5   52.1  47.6  57.0
  2  1.97E+07 (  78) 9.61E+06 (  38) 121.0  81.4 183.1   0.0   53.7  49.1  58.7
POOL 9.24E+06( 1541) 1.02E+07( 1706)                     0.0   53.7  49.1  58.7

MEAN URANIUM CONCENTRATION +/-2SE (ppm):  366.6,  21.0

 POOLED AGE WITH 68% CONF. INTERVAL(Ma):   53.7,  51.3 --  56.2 (  -2.4   +2.5)
                 95% CONF. INTERVAL(Ma):          49.1 --  58.7 (  -4.6   +5.0)
      REDUCED CHI^2, DEGREES OF FREEDOM:    2.0873,   35
                     CHI^2 PROBABILITY:    0.0%

CENTRAL AGE WITH 68% CONF. INTERVAL(Ma):   52.7,  49.7 --  55.9 (  -3.0   +3.2)
                 95% CONF. INTERVAL(Ma):          47.0 --  59.1 (  -5.7   +6.4)
                    AGE DISPERSION (%):   21.5

 CHI^2 AGE WITH 68% CONF. INTERVAL (Ma):   52.1,  49.8 --  54.6 (  -2.4   +2.5)
                95% CONF. INTERVAL (Ma):          47.6 --  57.0 (  -4.5   +4.9)
        NUMBER AND PERCENTAGE OF GRAINS:   35,    97%
```

==================ZetaAge Program v. 4.8 (Brandon 8/13/02)==================

TI10-02: Sheep Bay Granite
Location: Sheep Bay, SW of Sahlin Falls
GPS: N 60° 41.451′, W 145° 58.121′ SL
Etch Times: 23.75, 23.0, 16 hr
- Massive jointed coarse-grained equigranular granite with feldspar, quartz, and biotite.

DATE/TIME: 03-01-2011/14:23:14 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-02.FTZ
TI10-02A,B,C Orca Group - FEB 2011

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.377E+05
RELATIVE ERROR (%): 1.54
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	
1	5.73E+06	(34)	1.23E+07	(73)	9	448	105	27.3	17.6	41.5
2	7.59E+06	(40)	1.19E+07	(63)	8	435	110	37.2	24.3	56.1
3	9.29E+06	(49)	1.57E+07	(83)	8	573	127	34.6	23.8	49.8
4	4.93E+06	(26)	6.26E+06	(33)	8	228	79	46.1	26.5	79.3
5	7.40E+06	(39)	1.12E+07	(59)	8	408	106	38.7	25.1	58.9
6	5.69E+06	(30)	1.19E+07	(63)	8	435	110	28.0	17.4	43.7
7	6.83E+06	(36)	1.14E+07	(60)	8	415	107	35.2	22.6	53.9
8	1.27E+07	(67)	1.57E+07	(83)	8	573	127	47.2	33.7	65.9
9	6.83E+06	(36)	1.38E+07	(73)	8	504	119	28.9	18.8	43.6
10	5.31E+06	(28)	9.29E+06	(49)	8	339	97	33.5	20.2	54.3
11	9.67E+06	(51)	1.42E+07	(75)	8	518	120	39.8	27.3	57.5
12	6.07E+06	(36)	9.44E+06	(56)	9	344	92	37.7	24.0	58.2
13	1.29E+07	(34)	2.01E+07	(53)	4	732	202	37.6	23.7	58.8
14	6.83E+06	(36)	1.33E+07	(70)	8	484	116	30.2	19.6	45.6
15	5.50E+06	(29)	1.46E+07	(77)	8	532	122	22.1	13.9	34.2

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.358E+05
RELATIVE ERROR (%): 1.55
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	
16	8.92E+06	(47)	1.16E+07	(61)	8	424	109	44.8	30.0	66.6
17	5.88E+06	(31)	7.97E+06	(42)	8	292	90	43.0	26.1	69.9
18	4.55E+06	(24)	7.97E+06	(42)	8	292	90	33.4	19.3	56.2
19	7.21E+06	(38)	1.19E+07	(63)	8	438	111	35.2	22.8	53.3
20	5.31E+06	(28)	1.10E+07	(58)	8	403	106	28.2	17.2	44.8
21	6.45E+06	(34)	9.48E+06	(50)	8	347	98	39.6	24.8	62.3
22	7.97E+06	(42)	1.16E+07	(61)	8	424	109	40.1	26.4	60.3
23	7.02E+06	(37)	9.29E+06	(49)	8	340	97	44.0	27.9	68.6
24	7.40E+06	(39)	7.97E+06	(42)	8	292	90	54.0	34.0	85.4
25	7.97E+06	(42)	9.86E+06	(52)	8	361	100	47.0	30.5	71.8
26	8.16E+06	(43)	1.46E+07	(77)	8	535	123	32.6	21.8	47.8
27	7.40E+06	(39)	1.25E+07	(66)	8	459	113	34.4	22.5	51.8

==================ZetaAge Program v. 4.8 (Brandon 8/13/02)==================
DATE/TIME: 03-01-2011/14:23:14 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-02.FTZ

TI10-02A,B,C Orca Group - FEB 2011

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.339E+05
RELATIVE ERROR (%): 1.57
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	
28	9.39E+06	(99)	1.50E+07	(158)	16	552	89	36.3	28.1	46.9
29	7.06E+06	(93)	1.62E+07	(213)	20	595	84	25.4	19.8	32.5
30	8.16E+06	(86)	1.50E+07	(158)	16	552	89	31.6	24.2	41.3
31	8.19E+06	(81)	1.28E+07	(127)	15	473	85	37.0	27.9	49.1
32	6.88E+06	(68)	1.28E+07	(127)	15	473	85	31.0	22.7	42.0
33	5.41E+06	(57)	1.20E+07	(127)	16	444	80	26.0	18.7	35.8
34	7.66E+06	(101)	1.38E+07	(182)	20	509	77	32.2	25.1	41.3
35	6.90E+06	(91)	1.44E+07	(190)	20	531	79	27.8	21.5	35.9
36	8.73E+06	(115)	2.12E+07	(280)	20	783	97	23.8	19.1	29.8
37	9.64E+06	(127)	1.43E+07	(189)	20	528	79	38.9	30.9	49.0
38	9.26E+06	(122)	2.19E+07	(288)	20	805	98	24.6	19.8	30.6
39	1.42E+07	(150)	1.56E+07	(165)	16	576	91	52.5	41.9	65.9
40	1.02E+07	(135)	1.19E+07	(157)	20	439	71	49.7	39.3	62.9
41	6.07E+06	(80)	8.50E+06	(112)	20	313	60	41.4	30.9	55.4
42	7.44E+06	(98)	1.24E+07	(163)	20	456	73	34.9	27.0	45.0

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:14 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-02.FTZ
TI10-02A,B,C Orca Group - FEB 2011
Number of grains = 42

------ GRAIN AGES ORDERED WITH INCREASING AGE ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Grain age (Ma) Age	--95% CI--		P(X2) (%)	Sum age (Ma) Age	--95% CI--	
15	5.50E+06	(29)	1.46E+07	(77)	22.1	13.9	34.2	100.0	22.1	13.9	34.2
36	8.73E+06	(115)	2.12E+07	(280)	23.8	19.1	29.8	75.8	23.5	19.2	28.7
38	9.26E+06	(122)	2.19E+07	(288)	24.6	19.8	30.6	90.7	23.9	20.5	27.9
29	7.06E+06	(93)	1.62E+07	(213)	25.4	19.8	32.5	95.1	24.3	21.2	27.8
33	5.41E+06	(57)	1.20E+07	(127)	26.0	18.7	35.8	97.3	24.5	21.6	27.8
1	5.73E+06	(34)	1.23E+07	(73)	27.3	17.6	41.5	98.0	24.7	21.8	27.9
35	6.90E+06	(91)	1.44E+07	(190)	27.8	21.5	35.9	96.2	25.1	22.4	28.2
6	5.69E+06	(30)	1.19E+07	(63)	28.0	17.4	43.7	97.6	25.3	22.6	28.3
20	5.31E+06	(28)	1.10E+07	(58)	28.2	17.2	44.8	98.5	25.4	22.7	28.4
9	6.83E+06	(36)	1.38E+07	(73)	28.9	18.8	43.6	98.7	25.6	22.9	28.5
14	6.83E+06	(36)	1.33E+07	(70)	30.2	19.6	45.6	98.5	25.8	23.2	28.7
32	6.88E+06	(68)	1.28E+07	(127)	31.0	22.7	42.0	96.3	26.2	23.6	29.1
30	8.16E+06	(86)	1.50E+07	(158)	31.6	24.2	41.3	92.0	26.7	24.1	29.5
34	7.66E+06	(101)	1.38E+07	(182)	32.2	25.1	41.3	84.7	27.2	24.6	29.9
26	8.16E+06	(43)	1.46E+07	(77)	32.6	21.8	47.8	84.5	27.4	24.9	30.1
18	4.55E+06	(24)	7.97E+06	(42)	33.4	19.3	56.2	85.9	27.5	25.0	30.2
10	5.31E+06	(28)	9.29E+06	(49)	33.5	20.2	54.3	86.6	27.6	25.1	30.3
27	7.40E+06	(39)	1.25E+07	(66)	34.4	22.5	51.8	84.9	27.8	25.3	30.5
3	9.29E+06	(49)	1.57E+07	(83)	34.6	23.8	49.8	82.0	28.1	25.6	30.8
42	7.44E+06	(98)	1.24E+07	(163)	34.9	27.0	45.0	71.6	28.5	26.1	31.2
19	7.21E+06	(38)	1.19E+07	(63)	35.2	22.8	53.3	71.2	28.7	26.2	31.3
7	6.83E+06	(36)	1.14E+07	(60)	35.2	22.6	53.9	71.3	28.8	26.4	31.5
28	9.39E+06	(99)	1.50E+07	(158)	36.3	28.1	46.9	58.8	29.2	26.8	31.9
31	8.19E+06	(81)	1.28E+07	(127)	37.0	27.9	49.1	49.5	29.6	27.2	32.2
2	7.59E+06	(40)	1.19E+07	(63)	37.2	24.3	56.1	48.3	29.7	27.3	32.4
13	1.29E+07	(34)	2.01E+07	(53)	37.6	23.7	58.8	47.9	29.9	27.5	32.5
12	6.07E+06	(36)	9.44E+06	(56)	37.7	24.0	58.2	47.4	30.0	27.6	32.6
5	7.40E+06	(39)	1.12E+07	(59)	38.7	25.1	58.9	45.0	30.2	27.8	32.8

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 37  9.64E+06 ( 127) 1.43E+07 ( 189)  38.9  30.9  49.0  28.7   30.7  28.3  33.3
 21  6.45E+06 (  34) 9.48E+06 (  50)  39.6  24.8  62.3  27.9   30.8  28.4  33.4
 11  9.67E+06 (  51) 1.42E+07 (  75)  39.8  27.3  57.5  24.8   31.0  28.6  33.6
 22  7.97E+06 (  42) 1.16E+07 (  61)  40.1  26.4  60.3  23.2   31.2  28.8  33.8
 41  6.07E+06 (  80) 8.50E+06 ( 112)  41.4  30.9  55.4  15.9   31.5  29.1  34.1
 17  5.88E+06 (  31) 7.97E+06 (  42)  43.0  26.1  69.9  14.5   31.6  29.2  34.2
 23  7.02E+06 (  37) 9.29E+06 (  49)  44.0  27.9  68.6  12.1   31.8  29.4  34.4
 16  8.92E+06 (  47) 1.16E+07 (  61)  44.8  30.0  66.6   8.7   32.0  29.6  34.6

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:14 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-02.FTZ
TI10-02A,B,C Orca Group - FEB 2011
Number of grains =  42
------ GRAIN AGES ORDERED WITH INCREASING AGE ------
Grain  RhoS    (Ns)    RhoI    (Ni)    Grain age (Ma)  P(X2)     Sum age (Ma)
 no.  (cm^-2)         (cm^-2)         Age   --95% CI--  (%)    Age   --95% CI--
  4  4.93E+06 (  26) 6.26E+06 (  33)  46.1  26.5  79.3   7.7   32.1  29.7  34.7
 25  7.97E+06 (  42) 9.86E+06 (  52)  47.0  30.5  71.8   5.2   32.3  29.9  35.0
  8  1.27E+07 (  67) 1.57E+07 (  83)  47.2  33.7  65.9   2.4   32.6  30.2  35.3
 40  1.02E+07 ( 135) 1.19E+07 ( 157)  49.7  39.3  62.9   0.2   33.3  30.8  36.0
 39  1.42E+07 ( 150) 1.56E+07 ( 165)  52.5  41.9  65.9   0.0   34.1  31.6  36.7
 24  7.40E+06 (  39) 7.97E+06 (  42)  54.0  34.0  85.4   0.0   34.2  31.7  36.9
POOL 7.83E+06( 2518) 1.34E+07( 4303)                    0.0   34.2  31.7  36.9

MEAN URANIUM CONCENTRATION +/-2SE (ppm):  487.3,  21.1

 POOLED AGE WITH 68% CONF. INTERVAL(Ma):   34.2,  33.0 --  35.6 (  -1.3   +1.3)
                95% CONF. INTERVAL(Ma):         31.7 --  36.9 (  -2.5   +2.7)
     REDUCED CHI^2, DEGREES OF FREEDOM:    2.1710,   41
                     CHI^2 PROBABILITY:    0.0%

CENTRAL AGE WITH 68% CONF. INTERVAL(Ma):   34.9,  33.2 --  36.5 (  -1.6   +1.7)
                95% CONF. INTERVAL(Ma):         31.8 --  38.2 (  -3.1   +3.4)
                    AGE DISPERSION (%):   16.6

 CHI^2 AGE WITH 68% CONF. INTERVAL (Ma):   32.6,  31.4 --  34.0 (  -1.3   +1.3)
               95% CONF. INTERVAL (Ma):         30.2 --  35.3 (  -2.4   +2.6)
       NUMBER AND PERCENTAGE OF GRAINS:   39,    93%
```

==================ZetaAge Program v. 4.8 (Brandon 8/13/02)==================

TI10-03: Orca Group Conglomerate
Location: Simpson Bay
GPS: N 60° 37.678′, W 145° 53.944′ SL
Etch Times: 23.75, 23.0, 20.5 hr
- Thick-bedded conglomerate with inner interbedded coarse sandstone. Conglomerate is organized pebble- to cobble-sized clasts. Clasts are rounded to well-rounded. Lithologies are predominantly sandstones with some siltstones. No granite clasts observed. Bedding is near-vertical. Fractures observed in clasts and throughout outcrop, but not veined. Good stratal continuity.

DATE/TIME: 03-01-2011/14:23:20 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-03.FTZ
TI10-03A,B,C Orca Group - FEB 2011

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.320E+05
RELATIVE ERROR (%): 1.59
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	
1	1.44E+07	(38)	1.63E+07	(43)	4	604	184	50.8	32.0	80.4
2	5.31E+06	(21)	2.53E+06	(10)	6	94	58	119.0	54.3	282.1
3	1.33E+07	(35)	1.18E+07	(31)	4	436	156	64.8	38.9	108.4
4	1.04E+07	(41)	8.85E+06	(35)	6	328	111	67.2	41.8	108.5
5	7.84E+06	(31)	4.30E+06	(17)	6	159	76	103.9	56.2	199.7
6	2.36E+06	(14)	3.20E+06	(19)	9	119	54	42.5	19.7	88.9
7	6.83E+06	(27)	7.33E+06	(29)	6	272	100	53.5	30.5	93.4
8	1.11E+07	(44)	1.34E+07	(53)	6	497	137	47.8	31.3	72.5
9	9.36E+06	(37)	5.56E+06	(22)	6	206	87	96.0	55.5	170.6
10	8.09E+06	(32)	7.84E+06	(31)	6	290	104	59.3	35.1	100.2
11	7.84E+06	(31)	6.83E+06	(27)	6	253	97	65.9	38.1	114.5
12	1.39E+07	(55)	1.09E+07	(43)	6	403	123	73.3	48.4	111.8
13	9.10E+06	(36)	1.06E+07	(42)	6	394	121	49.3	30.7	78.7
14	7.25E+06	(43)	8.60E+06	(51)	9	319	89	48.5	31.5	74.1
15	1.11E+07	(44)	1.57E+07	(62)	6	581	148	40.9	27.1	61.0

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.302E+05
RELATIVE ERROR (%): 1.61
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	
16	4.30E+06	(17)	3.29E+06	(13)	6	122	67	74.4	34.2	166.0
17	4.17E+06	(22)	8.16E+06	(43)	8	304	93	29.4	16.7	50.0
18	1.01E+07	(40)	1.01E+07	(40)	6	377	119	57.1	35.9	90.7
19	2.87E+06	(17)	2.70E+06	(16)	9	100	50	60.6	28.9	127.8
20	3.03E+06	(12)	3.54E+06	(14)	6	132	69	49.1	20.7	113.6
21	6.83E+06	(27)	8.35E+06	(33)	6	311	108	46.8	27.1	80.1
22	1.09E+07	(43)	1.01E+07	(40)	6	377	119	61.4	39.0	96.7
23	8.35E+06	(33)	9.86E+06	(39)	6	367	118	48.4	29.5	78.8
24	7.08E+06	(28)	1.06E+07	(42)	6	396	122	38.2	22.8	63.0
25	4.81E+06	(19)	8.60E+06	(34)	6	320	110	32.1	17.2	57.6

>>NEW PARAMETERS--ZETA METHOD<<

EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.283E+05
RELATIVE ERROR (%): 1.64
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:20 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-03.FTZ
TI10-03A,B,C Orca Group - FEB 2011

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	
26	7.59E+06	(30)	8.60E+06	(34)	6	322	110	50.2	29.7	84.3
27	1.11E+07	(44)	6.32E+06	(25)	6	237	94	99.3	59.8	169.1
28	1.33E+07	(35)	1.59E+07	(42)	4	597	184	47.4	29.4	75.9
29	8.73E+06	(23)	1.06E+07	(28)	4	398	150	46.8	25.7	83.9
30	1.75E+07	(46)	2.20E+07	(58)	4	824	217	45.1	29.9	67.5
31	1.48E+07	(39)	1.93E+07	(51)	4	725	203	43.5	27.9	67.3
32	7.08E+06	(28)	8.35E+06	(33)	6	313	109	48.3	28.1	82.2
33	1.14E+07	(45)	1.26E+07	(50)	6	474	134	51.2	33.4	78.0
34	1.16E+07	(46)	1.24E+07	(49)	6	464	133	53.3	34.9	81.4
35	5.31E+06	(21)	5.82E+06	(23)	6	218	90	51.9	27.3	97.8
36	9.48E+06	(25)	1.29E+07	(34)	4	483	165	41.9	23.9	72.1
37	1.21E+07	(32)	1.33E+07	(35)	4	497	168	52.0	31.2	86.3
38	3.03E+06	(12)	2.02E+06	(8)	6	76	52	84.4	32.1	237.1
39	6.58E+06	(26)	8.09E+06	(32)	6	303	107	46.2	26.4	79.9
40	7.59E+06	(30)	1.06E+07	(42)	6	398	123	40.7	24.6	66.4

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:20 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-03.FTZ
TI10-03A,B,C Orca Group - FEB 2011
Number of grains = 40

------ GRAIN AGES ORDERED WITH INCREASING AGE ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Grain age (Ma) Age	--95% CI--		P(X2) (%)	Sum age (Ma) Age	--95% CI--	
17	4.17E+06	(22)	8.16E+06	(43)	29.4	16.7	50.0	100.0	29.6	16.8	50.3
25	4.81E+06	(19)	8.60E+06	(34)	32.1	17.2	57.6	82.0	30.7	20.4	45.4
24	7.08E+06	(28)	1.06E+07	(42)	38.2	22.8	63.0	75.1	33.1	24.2	44.9
40	7.59E+06	(30)	1.06E+07	(42)	40.7	24.6	66.4	78.1	35.2	27.3	45.4
15	1.11E+07	(44)	1.57E+07	(62)	40.9	27.1	61.0	83.0	36.7	29.6	45.6
36	9.48E+06	(25)	1.29E+07	(34)	41.9	23.9	72.1	89.1	37.4	30.6	45.8
6	2.36E+06	(14)	3.20E+06	(19)	42.5	19.7	88.9	93.7	37.8	31.1	45.9
31	1.48E+07	(39)	1.93E+07	(51)	43.5	27.9	67.3	95.0	38.7	32.3	46.2
30	1.75E+07	(46)	2.20E+07	(58)	45.1	29.9	67.5	95.3	39.6	33.6	46.8
39	6.58E+06	(26)	8.09E+06	(32)	46.2	26.4	79.9	96.5	40.1	34.2	47.1
29	8.73E+06	(23)	1.06E+07	(28)	46.8	25.7	83.9	97.5	40.5	34.7	47.3
21	6.83E+06	(27)	8.35E+06	(33)	46.8	27.1	80.1	98.2	41.0	35.3	47.6
28	1.33E+07	(35)	1.59E+07	(42)	47.4	29.4	75.9	98.5	41.5	35.9	47.9
8	1.11E+07	(44)	1.34E+07	(53)	47.8	31.3	72.5	98.7	42.1	36.6	48.3
32	7.08E+06	(28)	8.35E+06	(33)	48.3	28.1	82.2	99.1	42.4	37.1	48.5
23	8.35E+06	(33)	9.86E+06	(39)	48.4	29.5	78.8	99.3	42.8	37.5	48.7
14	7.25E+06	(43)	8.60E+06	(51)	48.5	31.5	74.1	99.5	43.2	38.0	49.0
20	3.03E+06	(12)	3.54E+06	(14)	49.1	20.7	113.6	99.7	43.3	38.2	49.1
13	9.10E+06	(36)	1.06E+07	(42)	49.3	30.7	78.7	99.8	43.6	38.6	49.3
26	7.59E+06	(30)	8.60E+06	(34)	50.2	29.7	84.3	99.8	43.9	38.9	49.5
1	1.44E+07	(38)	1.63E+07	(43)	50.8	32.0	80.4	99.8	44.3	39.3	49.8
33	1.14E+07	(45)	1.26E+07	(50)	51.2	33.4	78.0	99.9	44.6	39.8	50.1
35	5.31E+06	(21)	5.82E+06	(23)	51.9	27.3	97.8	99.9	44.8	40.0	50.2

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 37  1.21E+07 (  32) 1.33E+07 (  35)  52.0  31.2  86.3  99.9   45.1  40.3  50.5
 34  1.16E+07 (  46) 1.24E+07 (  49)  53.3  34.9  81.4  99.9   45.5  40.8  50.8
  7  6.83E+06 (  27) 7.33E+06 (  29)  53.5  30.5  93.4  99.9   45.7  41.0  51.0
 18  1.01E+07 (  40) 1.01E+07 (  40)  57.1  35.9  90.7  99.9   46.2  41.5  51.4
 10  8.09E+06 (  32) 7.84E+06 (  31)  59.3  35.1 100.2  99.9   46.5  41.9  51.7
 19  2.87E+06 (  17) 2.70E+06 (  16)  60.6  28.9 127.8  99.9   46.7  42.1  51.9
 22  1.09E+07 (  43) 1.01E+07 (  40)  61.4  39.0  96.7  99.7   47.3  42.6  52.4
  3  1.33E+07 (  35) 1.18E+07 (  31)  64.8  38.9 108.4  99.5   47.7  43.1  52.9
 11  7.84E+06 (  31) 6.83E+06 (  27)  65.9  38.1 114.5  99.1   48.1  43.5  53.3
  4  1.04E+07 (  41) 8.85E+06 (  35)  67.2  41.8 108.5  98.3   48.7  44.0  53.8
 12  1.39E+07 (  55) 1.09E+07 (  43)  73.3  48.4 111.8  94.0   49.5  44.8  54.6
 16  4.30E+06 (  17) 3.29E+06 (  13)  74.4  34.2 166.0  93.1   49.7  45.1  54.9
 38  3.03E+06 (  12) 2.02E+06 (   8)  84.4  32.1 237.1  91.7   50.0  45.3  55.1

==================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:20 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-03.FTZ
TI10-03A,B,C Orca Group - FEB 2011
Number of grains =  40
------ GRAIN AGES ORDERED WITH INCREASING AGE ------
Grain  RhoS    (Ns)    RhoI    (Ni)    Grain age (Ma)  P(X2)     Sum age (Ma)
 no.  (cm^-2)         (cm^-2)         Age   --95% CI--  (%)    Age   --95% CI--
  9  9.36E+06 (  37) 5.56E+06 (  22)  96.0  55.5 170.6  74.3   50.7  46.0  55.9
 27  1.11E+07 (  44) 6.32E+06 (  25)  99.3  59.8 169.1  44.2   51.6  46.9  56.9
  5  7.84E+06 (  31) 4.30E+06 (  17) 103.9  56.2 199.7  26.0   52.3  47.5  57.6
  2  5.31E+06 (  21) 2.53E+06 (  10) 119.0  54.3 282.1  15.0   52.8  48.0  58.1
POOL 8.19E+06( 1269) 8.92E+06( 1381)                    15.0   52.8  48.0  58.1

MEAN URANIUM CONCENTRATION +/-2SE (ppm):  330.3,  20.7

 POOLED AGE WITH 68% CONF. INTERVAL(Ma):   52.8,  50.3 --  55.4 (  -2.5   +2.6)
                 95% CONF. INTERVAL(Ma):         48.0 --  58.1 (  -4.8   +5.3)
      REDUCED CHI^2, DEGREES OF FREEDOM:    1.2336,   39
                      CHI^2 PROBABILITY:   15.0%

CENTRAL AGE WITH 68% CONF. INTERVAL(Ma):   52.9,  50.3 --  55.7 (  -2.7   +2.8)
                 95% CONF. INTERVAL(Ma):         47.9 --  58.5 (  -5.1   +5.6)
                     AGE DISPERSION (%):    9.8

 CHI^2 AGE WITH 68% CONF. INTERVAL (Ma):   52.8,  50.3 --  55.4 (  -2.5   +2.6)
                95% CONF. INTERVAL (Ma):         48.0 --  58.1 (  -4.8   +5.3)
        NUMBER AND PERCENTAGE OF GRAINS:   40,   100%
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==================ZetaAge Program v. 4.8 (Brandon 8/13/02)==================

TI10-04: Orca Group Turbidite
Location: Mainland, NW of Channel Island
GPS: N 60° 36.897′, W 145° 50.052 SL
Etch Times: 24.5, 23.0, 20.5 hr
- Medium- to thin-bedded sandstone with interbedded shale. Sandstone to shale ratio is 1:2. Graded beds.

DATE/TIME: 03-01-2011/14:23:27 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-04.FTZ
TI10-04A,B,C Orca Group - FEB 2011

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.264E+05
RELATIVE ERROR (%): 1.67
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U	+/-2s	Grain Age	Age (Ma) --95% CI--	
1	1.56E+07	(41)	1.37E+07	(36)	4	515	171	64.2	40.1	103.3
2	3.03E+06	(12)	9.36E+06	(37)	6	353	116	18.5	8.7	36.0
3	1.14E+07	(30)	1.33E+07	(35)	4	500	169	48.5	28.7	81.1
4	1.40E+07	(37)	1.67E+07	(44)	4	629	190	47.6	29.8	75.2
5	8.85E+06	(35)	1.04E+07	(41)	6	391	122	48.3	29.8	77.6
6	1.52E+07	(40)	7.21E+06	(19)	4	272	123	117.8	67.1	214.9
7	5.69E+06	(15)	6.83E+06	(18)	4	257	120	47.2	22.1	98.7
8	1.63E+07	(43)	1.06E+07	(28)	4	400	151	86.4	52.6	144.2
9	5.31E+06	(14)	4.93E+06	(13)	4	186	101	60.7	26.6	139.7
10	7.21E+06	(19)	4.93E+06	(13)	4	186	101	82.1	38.7	180.2
11	8.35E+06	(22)	4.55E+06	(12)	4	172	97	102.5	49.0	226.7
12	1.25E+07	(33)	9.86E+06	(26)	4	372	145	71.5	41.6	124.3
13	8.35E+06	(22)	1.14E+07	(30)	4	429	156	41.5	22.8	74.2

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.246E+05
RELATIVE ERROR (%): 1.70
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U	+/-2s	Grain Age	Age (Ma) --95% CI--	
14	1.37E+07	(36)	6.07E+06	(16)	4	230	114	125.0	68.2	240.6
15	1.10E+07	(29)	1.33E+07	(35)	4	503	170	46.6	27.5	78.3
16	8.35E+06	(44)	9.48E+06	(50)	8	359	102	49.5	32.2	75.6
17	5.82E+06	(23)	5.82E+06	(23)	6	220	91	56.2	30.1	104.5
18	1.04E+07	(41)	7.84E+06	(31)	6	297	106	74.1	45.4	122.0
19	9.86E+06	(26)	7.21E+06	(19)	4	273	124	76.5	40.9	146.0
20	1.47E+07	(58)	1.19E+07	(47)	6	450	132	69.2	46.3	103.9
21	8.85E+06	(35)	1.06E+07	(42)	6	403	124	46.9	29.0	75.1
22	2.36E+06	(14)	6.41E+06	(38)	9	243	79	20.9	10.4	39.2
23	7.08E+06	(28)	1.06E+07	(42)	6	403	124	37.6	22.4	61.9
24	6.07E+06	(16)	9.86E+06	(26)	4	374	146	34.8	17.4	66.9
25	8.35E+06	(33)	1.34E+07	(53)	6	508	140	35.1	22.0	55.1
26	5.82E+06	(23)	6.07E+06	(24)	6	230	93	53.8	29.1	99.3
27	4.30E+06	(17)	6.07E+06	(24)	6	230	93	39.9	20.1	77.2
28	1.01E+07	(40)	1.16E+07	(46)	6	441	130	48.9	31.2	76.3

==================ZetaAge Program v. 4.8 (Brandon 8/13/02)==================

DATE/TIME: 03-01-2011/14:23:27 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-04.FTZ
TI10-04A,B,C Orca Group - FEB 2011

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.227E+05
RELATIVE ERROR (%): 1.73
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age (Ma) Age	--95% CI--	
29	5.56E+06	(22)	1.14E+07	(45)	6	434	129	27.5	15.6	46.5
30	5.56E+06	(22)	5.56E+06	(22)	6	212	90	55.8	29.5	105.4
31	5.82E+06	(23)	5.56E+06	(22)	6	212	90	58.3	31.1	109.5
32	1.59E+07	(63)	1.62E+07	(64)	6	617	155	55.0	38.2	79.1
33	1.26E+07	(50)	1.85E+07	(73)	6	704	166	38.3	26.2	55.7
34	8.73E+06	(23)	1.02E+07	(27)	4	390	150	47.6	26.1	86.0
35	1.14E+07	(30)	1.33E+07	(35)	4	506	171	47.9	28.4	80.2
36	1.71E+07	(45)	1.90E+07	(50)	4	723	205	50.3	32.8	76.7
37	1.18E+07	(31)	1.02E+07	(27)	4	390	150	64.0	37.0	111.3
38	7.33E+06	(29)	1.09E+07	(43)	6	415	127	37.8	22.7	61.8
39	1.10E+07	(29)	1.18E+07	(31)	4	448	160	52.3	30.4	89.5
40	1.89E+07	(199)	1.98E+07	(209)	16	756	108	53.2	43.4	65.1
41	9.86E+06	(26)	1.44E+07	(38)	4	549	178	38.3	22.3	64.6
42	1.19E+07	(47)	8.09E+06	(32)	6	308	109	81.7	51.2	132.2
43	1.52E+07	(40)	1.40E+07	(37)	4	535	176	60.3	37.6	96.9

==================ZetaAge Program v. 4.8 (Brandon 8/13/02)==================
DATE/TIME: 03-01-2011/14:23:27 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-04.FTZ
TI10-04A,B,C Orca Group - FEB 2011
Number of grains = 43

------ GRAIN AGES ORDERED WITH INCREASING AGE ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Grain age (Ma) Age	--95% CI--		P(X2) (%)	Sum age (Ma) Age	--95% CI--	
2	3.03E+06	(12)	9.36E+06	(37)	18.5	8.7	36.0	100.0	18.5	8.7	36.0
22	2.36E+06	(14)	6.41E+06	(38)	20.9	10.4	39.2	78.9	19.7	12.1	31.1
29	5.56E+06	(22)	1.14E+07	(45)	27.5	15.6	46.5	60.3	22.5	15.7	31.7
24	6.07E+06	(16)	9.86E+06	(26)	34.8	17.4	66.9	49.0	24.7	18.1	33.3
25	8.35E+06	(33)	1.34E+07	(53)	35.1	22.0	55.1	39.8	27.5	21.4	35.3
23	7.08E+06	(28)	1.06E+07	(42)	37.6	22.4	61.9	38.0	29.2	23.4	36.5
38	7.33E+06	(29)	1.09E+07	(43)	37.8	22.7	61.8	40.3	30.5	24.9	37.4
41	9.86E+06	(26)	1.44E+07	(38)	38.3	22.3	64.6	44.7	31.4	26.0	38.0
33	1.26E+07	(50)	1.85E+07	(73)	38.3	26.2	55.7	46.4	32.7	27.5	38.9
27	4.30E+06	(17)	6.07E+06	(24)	39.9	20.1	77.2	53.1	33.1	28.0	39.1
13	8.35E+06	(22)	1.14E+07	(30)	41.5	22.8	74.2	57.0	33.7	28.6	39.6
15	1.10E+07	(29)	1.33E+07	(35)	46.6	27.5	78.3	52.2	34.6	29.6	40.4
21	8.85E+06	(35)	1.06E+07	(42)	46.9	29.0	75.1	47.4	35.6	30.7	41.3
7	5.69E+06	(15)	6.83E+06	(18)	47.2	22.1	98.7	50.7	36.0	31.1	41.6
4	1.40E+07	(37)	1.67E+07	(44)	47.6	29.8	75.2	47.7	36.8	32.0	42.4
34	8.73E+06	(23)	1.02E+07	(27)	47.6	26.1	86.0	49.6	37.3	32.5	42.8
35	1.14E+07	(30)	1.33E+07	(35)	47.9	28.4	80.2	50.2	37.9	33.1	43.3
5	8.85E+06	(35)	1.04E+07	(41)	48.3	29.8	77.6	50.2	38.5	33.8	43.8
3	1.14E+07	(30)	1.33E+07	(35)	48.5	28.7	81.1	51.7	38.9	34.3	44.3
28	1.01E+07	(40)	1.16E+07	(46)	48.9	31.2	76.3	51.6	39.5	34.9	44.8
16	8.35E+06	(44)	9.48E+06	(50)	49.5	32.2	75.6	51.2	40.1	35.6	45.3
36	1.71E+07	(45)	1.90E+07	(50)	50.3	32.8	76.7	50.6	40.7	36.2	45.8
39	1.10E+07	(29)	1.18E+07	(31)	52.3	30.4	89.5	51.3	41.1	36.6	46.2
40	1.89E+07	(199)	1.98E+07	(209)	53.2	43.4	65.1	28.4	43.4	39.0	48.3
26	5.82E+06	(23)	6.07E+06	(24)	53.8	29.1	99.3	31.0	43.6	39.2	48.5
32	1.59E+07	(63)	1.62E+07	(64)	55.0	38.2	79.1	28.7	44.2	39.9	49.0

```
 30  5.56E+06 (  22) 5.56E+06 (  22)  55.8  29.5 105.4  30.9   44.4  40.1  49.2
 17  5.82E+06 (  23) 5.82E+06 (  23)  56.2  30.1 104.5  33.0   44.6  40.3  49.4
 31  5.82E+06 (  23) 5.56E+06 (  22)  58.3  31.1 109.5  34.3   44.9  40.6  49.7
 43  1.52E+07 (  40) 1.40E+07 (  37)  60.3  37.6  96.9  31.7   45.3  41.0  50.1
  9  5.31E+06 (  14) 4.93E+06 (  13)  60.7  26.6 139.7  33.9   45.5  41.2  50.2
 37  1.18E+07 (  31) 1.02E+07 (  27)  64.0  37.0 111.3  31.3   45.9  41.5  50.6
  1  1.56E+07 (  41) 1.37E+07 (  36)  64.2  40.1 103.3  27.1   46.3  42.0  51.1
 20  1.47E+07 (  58) 1.19E+07 (  47)  69.2  46.3 103.9  17.4   47.1  42.8  51.9
 12  1.25E+07 (  33) 9.86E+06 (  26)  71.5  41.6 124.3  13.9   47.5  43.2  52.3
 18  1.04E+07 (  41) 7.84E+06 (  31)  74.1  45.4 122.0   9.3   48.1  43.7  52.9

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:27 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-04.FTZ
TI10-04A,B,C Orca Group - FEB 2011
Number of grains =  43
------ GRAIN AGES ORDERED WITH INCREASING AGE ------
Grain  RhoS    (Ns)    RhoI    (Ni)    Grain age (Ma)  P(X2)     Sum age (Ma)
 no.  (cm^-2)         (cm^-2)         Age   --95% CI--  (%)    Age   --95% CI--
 19  9.86E+06 (  26) 7.21E+06 (  19)  76.5  40.9 146.0   7.5   48.4  44.1  53.2
 42  1.19E+07 (  47) 8.09E+06 (  32)  81.7  51.2 132.2   3.4   49.1  44.7  54.0
 10  7.21E+06 (  19) 4.93E+06 (  13)  82.1  38.7 180.2   2.9   49.4  45.0  54.3
  8  1.63E+07 (  43) 1.06E+07 (  28)  86.4  52.6 144.2   1.2   50.1  45.6  54.9
 11  8.35E+06 (  22) 4.55E+06 (  12) 102.5  49.0 226.7   0.6   50.5  46.0  55.4
  6  1.52E+07 (  40) 7.21E+06 (  19) 117.8  67.1 214.9   0.1   51.3  46.8  56.2
 14  1.37E+07 (  36) 6.07E+06 (  16) 125.0  68.2 240.6   0.0   52.0  47.5  57.0
POOL 9.97E+06( 1505) 1.08E+07( 1635)                       0.0   52.0  47.5  57.0

MEAN URANIUM CONCENTRATION +/-2SE (ppm):  408.2,  24.4

 POOLED AGE WITH 68% CONF. INTERVAL(Ma):   52.0,  49.6 --  54.5 (  -2.4   +2.5)
                 95% CONF. INTERVAL(Ma):          47.5 --  57.0 (  -4.5   +5.0)
      REDUCED CHI^2, DEGREES OF FREEDOM:    2.0238,   42
                      CHI^2 PROBABILITY:    0.0%

CENTRAL AGE WITH 68% CONF. INTERVAL(Ma):   52.1,  49.0 --  55.4 (  -3.1   +3.3)
                 95% CONF. INTERVAL(Ma):          46.3 --  58.7 (  -5.9   +6.6)
                     AGE DISPERSION (%):   24.4

 CHI^2 AGE WITH 68% CONF. INTERVAL (Ma):   50.1,  47.8 --  52.5 (  -2.3   +2.4)
                95% CONF. INTERVAL (Ma):          45.6 --  54.9 (  -4.4   +4.9)
        NUMBER AND PERCENTAGE OF GRAINS:   40,    93%
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===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================

TI10-05: Orca Group Turbidite
Location: Hawkins Is., West side of Salmo Point
GPS: N 60° 36.810′, W 145° 46.350′ SL
Etch Times: 24.5, 23.0, 20.5 hr
- Tip of Hawkins Island. Very well-bedded medium-bedded sandstone with minor shale. Sandstone to shale ratio is 5:1. Beds are steep and younger to the south.

DATE/TIME: 03-01-2011/14:23:36 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-05.FTZ
TI10-05A,B,C Orca Group - FEB 2011

>>NEW PARAMETERS--ZETA METHOD<<

EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.208E+05
RELATIVE ERROR (%): 1.77
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U	+/-2s	Grain Age	Age (Ma) --95% CI--	
1	7.21E+06	(19)	1.18E+07	(31)	4	451	161	34.2	18.2	62.2
2	4.74E+06	(25)	6.26E+06	(33)	8	240	83	42.2	24.0	72.9
3	9.10E+06	(36)	1.09E+07	(43)	6	417	127	46.5	29.0	74.1
4	8.73E+06	(23)	1.14E+07	(30)	4	436	159	42.7	23.6	75.7
5	8.60E+06	(34)	7.59E+06	(30)	6	291	106	62.8	37.4	106.1
6	9.61E+06	(38)	1.19E+07	(47)	6	456	133	45.0	28.5	70.3
7	6.32E+06	(25)	8.35E+06	(33)	6	320	111	42.2	24.0	72.9
8	1.40E+07	(37)	1.21E+07	(32)	4	465	164	64.1	38.9	106.1
9	4.55E+06	(12)	4.93E+06	(13)	4	189	103	51.3	21.4	121.3
10	6.58E+06	(26)	8.09E+06	(32)	6	310	109	45.2	25.8	78.1
11	1.57E+07	(62)	6.32E+06	(25)	6	242	96	136.3	84.9	225.9
12	5.69E+06	(15)	7.97E+06	(21)	4	305	132	39.8	19.0	80.6
13	3.79E+06	(10)	8.35E+06	(22)	4	320	135	25.5	10.7	55.6
14	5.56E+06	(22)	8.35E+06	(33)	6	320	111	37.2	20.6	65.4
15	1.75E+07	(46)	2.43E+07	(64)	4	931	234	40.0	26.7	59.3

>>NEW PARAMETERS--ZETA METHOD<<

EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.190E+05
RELATIVE ERROR (%): 1.81
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U	+/-2s	Grain Age	Age (Ma) --95% CI--	
16	7.21E+06	(19)	2.20E+07	(58)	4	848	224	18.2	10.2	30.9
17	9.10E+06	(36)	1.09E+07	(43)	6	419	128	46.3	28.8	73.7
18	7.59E+06	(30)	1.72E+07	(68)	6	663	162	24.5	15.3	38.1
19	3.54E+06	(21)	6.58E+06	(39)	9	254	81	29.9	16.6	51.9
20	7.59E+06	(30)	1.52E+07	(60)	6	585	152	27.7	17.2	43.6
21	5.69E+06	(15)	2.01E+07	(53)	4	775	214	15.8	8.2	28.2
22	7.59E+06	(20)	2.05E+07	(54)	4	790	216	20.6	11.6	34.8
23	2.28E+06	(9)	3.29E+06	(13)	6	127	69	38.5	14.4	96.4
24	7.08E+06	(28)	1.04E+07	(41)	6	400	125	37.8	22.5	62.5
25	1.14E+07	(45)	1.72E+07	(68)	6	663	162	36.6	24.5	54.1
26	1.01E+07	(60)	1.69E+07	(100)	9	650	132	33.2	23.6	46.2
27	1.48E+07	(39)	1.75E+07	(46)	4	673	199	46.9	29.8	73.3
28	1.52E+07	(40)	1.59E+07	(42)	4	614	190	52.6	33.2	83.0
29	4.81E+06	(19)	9.10E+06	(36)	6	351	117	29.3	15.8	52.2
30	4.93E+06	(13)	1.02E+07	(27)	4	395	151	26.8	12.6	53.4

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:36 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-05.FTZ
TI10-05A,B,C Orca Group - FEB 2011

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.171E+05
RELATIVE ERROR (%): 1.85
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	
31	1.37E+07	(72)	1.69E+07	(89)	8	655	141	44.4	32.1	61.4
32	9.61E+06	(38)	1.47E+07	(58)	6	569	150	36.1	23.3	55.2
33	9.61E+06	(38)	1.16E+07	(46)	6	451	133	45.4	28.7	71.2
34	1.39E+07	(55)	9.36E+06	(37)	6	363	119	81.3	52.7	126.8
35	9.29E+06	(49)	1.35E+07	(71)	8	522	125	38.0	25.8	55.4
36	5.31E+06	(28)	5.69E+06	(30)	8	221	80	51.3	29.5	88.6
37	1.37E+07	(72)	2.01E+07	(106)	8	780	154	37.4	27.2	50.9
38	7.97E+06	(42)	4.74E+06	(25)	8	184	73	91.7	54.8	156.8
39	6.26E+06	(33)	1.42E+07	(75)	8	552	129	24.3	15.5	36.9
40	9.48E+06	(50)	1.14E+07	(60)	8	441	115	45.8	30.8	67.7
41	6.64E+06	(35)	7.40E+06	(39)	8	287	92	49.3	30.3	79.8
42	1.19E+07	(63)	1.27E+07	(67)	8	493	121	51.6	36.0	73.9
43	1.56E+07	(82)	1.86E+07	(98)	8	721	148	46.0	33.8	62.3
44	1.52E+07	(80)	1.44E+07	(76)	8	559	130	57.7	41.6	80.2
45	4.17E+06	(22)	4.17E+06	(22)	8	162	69	54.9	29.0	103.6

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:36 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-05.FTZ
TI10-05A,B,C Orca Group - FEB 2011
Number of grains = 45

------ GRAIN AGES ORDERED WITH INCREASING AGE ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Grain age (Ma) Age	--95% CI--		P(X2) (%)	Sum age (Ma) Age	--95% CI--	
21	5.69E+06	(15)	2.01E+07	(53)	15.8	8.2	28.2	100.0	15.9	8.2	28.4
16	7.21E+06	(19)	2.20E+07	(58)	18.2	10.2	30.9	71.0	17.0	11.1	25.0
22	7.59E+06	(20)	2.05E+07	(54)	20.6	11.6	34.8	79.0	18.1	13.0	24.8
39	6.26E+06	(33)	1.42E+07	(75)	24.3	15.5	36.9	63.9	20.1	15.6	25.8
18	7.59E+06	(30)	1.72E+07	(68)	24.5	15.3	38.1	68.6	21.0	16.9	26.2
13	3.79E+06	(10)	8.35E+06	(22)	25.5	10.7	55.6	77.9	21.3	17.2	26.4
30	4.93E+06	(13)	1.02E+07	(27)	26.8	12.6	53.4	82.5	21.7	17.7	26.6
20	7.59E+06	(30)	1.52E+07	(60)	27.7	17.2	43.6	80.1	22.6	18.7	27.2
29	4.81E+06	(19)	9.10E+06	(36)	29.3	15.8	52.2	80.5	23.1	19.3	27.6
19	3.54E+06	(21)	6.58E+06	(39)	29.9	16.6	51.9	80.6	23.6	19.9	28.1
26	1.01E+07	(60)	1.69E+07	(100)	33.2	23.6	46.2	56.2	25.2	21.6	29.5
1	7.21E+06	(19)	1.18E+07	(31)	34.2	18.2	62.2	56.3	25.7	22.1	29.9
32	9.61E+06	(38)	1.47E+07	(58)	36.1	23.3	55.2	45.2	26.6	23.0	30.7
25	1.14E+07	(45)	1.72E+07	(68)	36.6	24.5	54.1	35.3	27.5	23.9	31.5
14	5.56E+06	(22)	8.35E+06	(33)	37.2	20.6	65.4	35.3	27.9	24.4	31.9
37	1.37E+07	(72)	2.01E+07	(106)	37.4	27.2	50.9	24.4	29.0	25.5	32.9
24	7.08E+06	(28)	1.04E+07	(41)	37.8	22.5	62.5	24.8	29.4	26.0	33.3
35	9.29E+06	(49)	1.35E+07	(71)	38.0	25.8	55.4	22.5	30.0	26.6	33.8
23	2.28E+06	(9)	3.29E+06	(13)	38.5	14.4	96.4	26.3	30.1	26.7	33.9
12	5.69E+06	(15)	7.97E+06	(21)	39.8	19.0	80.6	28.7	30.3	26.9	34.1
15	1.75E+07	(46)	2.43E+07	(64)	40.0	26.7	59.3	25.3	30.9	27.5	34.6
7	6.32E+06	(25)	8.35E+06	(33)	42.2	24.0	72.9	24.5	31.2	27.8	34.9
2	4.74E+06	(25)	6.26E+06	(33)	42.2	24.0	72.9	24.2	31.5	28.1	35.2
4	8.73E+06	(23)	1.14E+07	(30)	42.7	23.6	75.7	24.2	31.8	28.4	35.5

31	1.37E+07	(72)	1.69E+07	(89)	44.4	32.1	61.4	14.5	32.6	29.3	36.4
6	9.61E+06	(38)	1.19E+07	(47)	45.0	28.5	70.3	12.4	33.1	29.7	36.8
10	6.58E+06	(26)	8.09E+06	(32)	45.2	25.8	78.1	12.1	33.4	30.0	37.1
33	9.61E+06	(38)	1.16E+07	(46)	45.4	28.7	71.2	10.7	33.8	30.4	37.4
40	9.48E+06	(50)	1.14E+07	(60)	45.8	30.8	67.7	8.6	34.2	30.9	37.9
43	1.56E+07	(82)	1.86E+07	(98)	46.0	33.8	62.3	5.4	35.0	31.7	38.6
17	9.10E+06	(36)	1.09E+07	(43)	46.3	28.8	73.7	5.2	35.3	32.0	38.9
3	9.10E+06	(36)	1.09E+07	(43)	46.5	29.0	74.1	5.0	35.6	32.3	39.2
27	1.48E+07	(39)	1.75E+07	(46)	46.9	29.8	73.3	4.7	35.9	32.6	39.5
41	6.64E+06	(35)	7.40E+06	(39)	49.3	30.3	79.8	4.2	36.2	32.9	39.8
36	5.31E+06	(28)	5.69E+06	(30)	51.3	29.5	88.6	3.9	36.4	33.1	40.1
9	4.55E+06	(12)	4.93E+06	(13)	51.3	21.4	121.3	4.3	36.5	33.2	40.2

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:36 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-05.FTZ
TI10-05A,B,C Orca Group - FEB 2011
Number of grains = 45
------ GRAIN AGES ORDERED WITH INCREASING AGE ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Grain age (Ma) Age	--95%	CI--	P(X2) (%)	Sum age (Ma) Age	--95%	CI--
42	1.19E+07	(63)	1.27E+07	(67)	51.6	36.0	73.9	2.6	37.1	33.8	40.7
28	1.52E+07	(40)	1.59E+07	(42)	52.6	33.2	83.0	2.1	37.4	34.1	41.1
45	4.17E+06	(22)	4.17E+06	(22)	54.9	29.0	103.6	1.9	37.6	34.3	41.3
44	1.52E+07	(80)	1.44E+07	(76)	57.7	41.6	80.2	0.6	38.4	35.1	42.1
5	8.60E+06	(34)	7.59E+06	(30)	62.8	37.4	106.1	0.3	38.8	35.4	42.4
8	1.40E+07	(37)	1.21E+07	(32)	64.1	38.9	106.1	0.2	39.2	35.8	42.9
34	1.39E+07	(55)	9.36E+06	(37)	81.3	52.7	126.8	0.0	39.9	36.5	43.7
38	7.97E+06	(42)	4.74E+06	(25)	91.7	54.8	156.8	0.0	40.5	37.1	44.3
11	1.57E+07	(62)	6.32E+06	(25)	136.3	84.9	225.9	0.0	41.7	38.2	45.5
POOL	8.87E+06	(1613)	1.18E+07	(2151)				0.0	41.7	38.2	45.5

MEAN URANIUM CONCENTRATION +/-2SE (ppm): 453.4, 25.3

POOLED AGE WITH 68% CONF. INTERVAL(Ma): 41.7, 39.8 -- 43.6 (-1.8 +1.9)
95% CONF. INTERVAL(Ma): 38.2 -- 45.5 (-3.5 +3.8)
REDUCED CHI^2, DEGREES OF FREEDOM: 2.8447, 44
CHI^2 PROBABILITY: 0.0%

CENTRAL AGE WITH 68% CONF. INTERVAL(Ma): 41.4, 38.8 -- 44.2 (-2.6 +2.8)
95% CONF. INTERVAL(Ma): 36.5 -- 47.0 (-4.9 +5.6)
AGE DISPERSION (%): 30.6

CHI^2 AGE WITH 68% CONF. INTERVAL (Ma): 37.6, 35.9 -- 39.5 (-1.7 +1.8)
95% CONF. INTERVAL (Ma): 34.3 -- 41.3 (-3.3 +3.6)
NUMBER AND PERCENTAGE OF GRAINS: 39, 87%

==================ZetaAge Program v. 4.8 (Brandon 8/13/02)==================

TI10-06: Orca Group Turbidite
Location: Observation Is., Western Odiak Channel
GPS: N 60° 36.179′, W 145° 44.592′ SL
Etch Times: 24.5, 23.0, 20.5 hr
- Medium- to thick-bedded medium- to coarse-grained sandstone and minor interbedded shale.

DATE/TIME: 03-01-2011/14:23:42 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-06.FTZ
TI10-06A,B,C Orca Group - FEB 2011

>>NEW PARAMETERS--ZETA METHOD<<

EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2):	3.152E+05	
RELATIVE ERROR (%):	1.90	
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm):	12.30	
ZETA FACTOR AND STANDARD ERROR (yr cm^2):	347.50	8.76
SIZE OF COUNTER SQUARE (cm^2):	6.590E-07	

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	
1	9.74E+06	(77)	1.40E+07	(111)	12	548	106	37.9	27.9	51.2
2	1.08E+07	(57)	1.44E+07	(76)	8	563	130	41.0	28.5	58.5
3	8.22E+06	(65)	1.04E+07	(82)	12	405	90	43.3	30.7	60.7
4	6.07E+06	(48)	1.10E+07	(87)	12	429	93	30.2	20.7	43.4
5	2.02E+06	(20)	3.14E+06	(31)	15	122	44	35.3	19.0	63.8
6	3.26E+06	(43)	1.90E+06	(25)	20	74	29	93.3	55.9	159.2
7	7.59E+06	(25)	1.37E+07	(45)	5	533	159	30.4	17.8	50.6
8	4.99E+06	(46)	9.21E+06	(85)	14	360	79	29.6	20.2	42.9
9	9.48E+06	(100)	1.18E+07	(124)	16	459	84	44.1	33.7	57.7
10	1.43E+07	(151)	1.49E+07	(157)	16	581	95	52.5	41.7	66.1
11	1.29E+07	(153)	1.02E+07	(121)	18	398	74	68.8	53.9	87.9
12	1.29E+07	(102)	1.45E+07	(115)	12	567	108	48.4	36.9	63.5
13	7.21E+06	(38)	7.78E+06	(41)	8	303	95	50.6	31.6	80.6
14	6.74E+06	(80)	9.02E+06	(107)	18	352	69	40.8	30.1	55.1
15	1.34E+07	(159)	1.51E+07	(179)	18	589	91	48.5	38.9	60.5

>>NEW PARAMETERS--ZETA METHOD<<

EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2):	3.133E+05	
RELATIVE ERROR (%):	1.95	
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm):	12.30	
ZETA FACTOR AND STANDARD ERROR (yr cm^2):	347.50	8.76
SIZE OF COUNTER SQUARE (cm^2):	6.590E-07	

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age	Age (Ma) --95% CI--	
16	3.29E+06	(39)	7.33E+06	(87)	18	288	63	24.4	16.2	36.0
17	9.67E+06	(102)	9.86E+06	(104)	16	387	77	53.2	40.2	70.2
18	1.16E+07	(92)	1.47E+07	(116)	12	576	109	43.1	32.6	56.9
19	8.70E+06	(86)	1.03E+07	(102)	15	405	82	45.8	34.2	61.3
20	1.49E+07	(177)	1.53E+07	(182)	18	602	92	52.7	42.5	65.4
21	2.01E+07	(238)	2.16E+07	(256)	18	847	111	50.4	41.8	60.7
22	1.53E+07	(151)	5.67E+06	(56)	15	222	60	144.9	106.2	200.6
23	8.60E+06	(136)	1.16E+07	(183)	24	454	69	40.4	32.1	50.8
24	1.15E+07	(121)	1.80E+07	(190)	16	707	106	34.6	27.4	43.8
25	1.48E+07	(156)	1.01E+07	(107)	16	398	78	78.8	61.2	101.3
26	2.43E+07	(256)	2.57E+07	(271)	16	1009	129	51.2	42.7	61.4
27	6.90E+06	(91)	1.21E+07	(160)	20	477	78	31.0	23.8	40.3
28	4.11E+06	(65)	8.41E+06	(133)	24	330	59	26.6	19.4	36.1
29	1.21E+07	(159)	2.27E+07	(299)	20	891	109	28.9	23.6	35.4
30	8.16E+06	(86)	1.21E+07	(128)	16	477	86	36.5	27.6	48.3

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:42 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-06.FTZ
TI10-06A,B,C Orca Group - FEB 2011

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.115E+05
RELATIVE ERROR (%): 2.00
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U+/-2s		Grain Age (Ma) Age	--95% CI--	
31	7.97E+06	(105)	1.25E+07	(165)	20	494	79	34.4	26.8	44.2
32	3.49E+06	(46)	5.39E+06	(71)	20	213	51	35.0	23.6	51.5
33	2.19E+06	(36)	4.43E+06	(73)	25	175	41	26.7	17.3	40.3
34	1.18E+07	(124)	1.87E+07	(197)	16	738	109	34.0	27.0	42.9
35	1.02E+07	(134)	1.08E+07	(142)	20	425	73	50.9	39.9	64.9
36	9.56E+06	(126)	1.03E+07	(136)	20	407	72	50.0	38.9	64.1
37	1.15E+07	(151)	1.19E+07	(157)	20	470	77	51.9	41.2	65.3
38	7.26E+06	(67)	7.80E+06	(72)	14	308	73	50.2	35.4	71.0
39	8.06E+06	(85)	1.12E+07	(118)	16	442	83	38.9	29.3	51.7
40	7.59E+06	(70)	1.28E+07	(118)	14	505	95	32.1	23.4	43.5
41	8.90E+06	(88)	9.81E+06	(97)	15	387	80	48.9	36.2	66.1
42	1.14E+07	(113)	1.09E+07	(108)	15	431	85	56.4	43.0	73.8
43	1.37E+07	(181)	1.41E+07	(186)	20	557	85	52.5	42.4	64.9
44	2.58E+06	(34)	2.81E+06	(37)	20	111	36	49.6	30.2	81.1
45	1.15E+07	(152)	1.98E+07	(261)	20	782	102	31.5	25.5	38.8

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:42 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-06.FTZ
TI10-06A,B,C Orca Group - FEB 2011
Number of grains = 45

------ GRAIN AGES ORDERED WITH INCREASING AGE ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Grain age (Ma) Age	--95% CI--		P(X2) (%)	Sum age (Ma) Age	--95% CI--	
16	3.29E+06	(39)	7.33E+06	(87)	24.4	16.2	36.0	100.0	24.3	16.2	35.8
28	4.11E+06	(65)	8.41E+06	(133)	26.6	19.4	36.1	72.4	25.7	20.2	32.7
33	2.19E+06	(36)	4.43E+06	(73)	26.7	17.3	40.3	92.9	26.0	21.1	32.0
29	1.21E+07	(159)	2.27E+07	(299)	28.9	23.6	35.4	86.6	27.4	23.6	31.9
8	4.99E+06	(46)	9.21E+06	(85)	29.6	20.2	42.9	92.8	27.7	24.0	32.0
4	6.07E+06	(48)	1.10E+07	(87)	30.2	20.7	43.4	95.7	28.0	24.4	32.1
7	7.59E+06	(25)	1.37E+07	(45)	30.4	17.8	50.6	97.8	28.1	24.6	32.1
27	6.90E+06	(91)	1.21E+07	(160)	31.0	23.8	40.3	97.9	28.6	25.3	32.3
45	1.15E+07	(152)	1.98E+07	(261)	31.5	25.5	38.8	97.1	29.2	26.1	32.7
40	7.59E+06	(70)	1.28E+07	(118)	32.1	23.4	43.5	97.7	29.4	26.4	32.8
34	1.18E+07	(124)	1.87E+07	(197)	34.0	27.0	42.9	94.8	30.0	27.1	33.3
31	7.97E+06	(105)	1.25E+07	(165)	34.4	26.8	44.2	93.0	30.4	27.5	33.6
24	1.15E+07	(121)	1.80E+07	(190)	34.6	27.4	43.8	91.1	30.8	28.0	34.0
32	3.49E+06	(46)	5.39E+06	(71)	35.0	23.6	51.5	92.5	31.0	28.2	34.1
5	2.02E+06	(20)	3.14E+06	(31)	35.3	19.0	63.8	94.5	31.1	28.2	34.2
30	8.16E+06	(86)	1.21E+07	(128)	36.5	27.6	48.3	92.6	31.4	28.6	34.5
1	9.74E+06	(77)	1.40E+07	(111)	37.9	27.9	51.2	89.3	31.7	28.9	34.8
39	8.06E+06	(85)	1.12E+07	(118)	38.9	29.3	51.7	83.5	32.1	29.3	35.1
23	8.60E+06	(136)	1.16E+07	(183)	40.4	32.1	50.8	65.1	32.7	29.9	35.7
14	6.74E+06	(80)	9.02E+06	(107)	40.8	30.1	55.1	56.9	33.0	30.2	36.0
2	1.08E+07	(57)	1.44E+07	(76)	41.0	28.5	58.5	53.7	33.2	30.5	36.2
18	1.16E+07	(92)	1.47E+07	(116)	43.1	32.6	56.9	39.7	33.6	30.9	36.6
3	8.22E+06	(65)	1.04E+07	(82)	43.3	30.7	60.7	33.3	33.9	31.1	36.9
9	9.48E+06	(100)	1.18E+07	(124)	44.1	33.7	57.7	22.1	34.3	31.5	37.3
19	8.70E+06	(86)	1.03E+07	(102)	45.8	34.2	61.3	13.8	34.7	31.9	37.7

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 12  1.29E+07 ( 102) 1.45E+07 ( 115)  48.4  36.9  63.5   5.4   35.1  32.4  38.2
 15  1.34E+07 ( 159) 1.51E+07 ( 179)  48.5  38.9  60.5   1.0   35.8  33.0  38.9
 41  8.90E+06 (  88) 9.81E+06 (  97)  48.9  36.2  66.1   0.5   36.2  33.4  39.2
 44  2.58E+06 (  34) 2.81E+06 (  37)  49.6  30.2  81.1   0.4   36.3  33.5  39.4
 36  9.56E+06 ( 126) 1.03E+07 ( 136)  50.0  38.9  64.1   0.1   36.8  34.0  39.9
 38  7.26E+06 (  67) 7.80E+06 (  72)  50.2  35.4  71.0   0.1   37.1  34.3  40.1
 21  2.01E+07 ( 238) 2.16E+07 ( 256)  50.4  41.8  60.7   0.0   37.9  35.1  41.0
 13  7.21E+06 (  38) 7.78E+06 (  41)  50.6  31.6  80.6   0.0   38.1  35.2  41.1
 35  1.02E+07 ( 134) 1.08E+07 ( 142)  50.9  39.9  64.9   0.0   38.5  35.6  41.6
 26  2.43E+07 ( 256) 2.57E+07 ( 271)  51.2  42.7  61.4   0.0   39.3  36.4  42.4
 37  1.15E+07 ( 151) 1.19E+07 ( 157)  51.9  41.2  65.3   0.0   39.7  36.8  42.8

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:42 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-06.FTZ
TI10-06A,B,C Orca Group - FEB 2011
Number of grains =  45
------ GRAIN AGES ORDERED WITH INCREASING AGE ------
Grain  RhoS    (Ns)    RhoI    (Ni)    Grain age (Ma)  P(X2)     Sum age (Ma)
 no.  (cm^-2)         (cm^-2)          Age   --95% CI--  (%)    Age   --95% CI--
 43  1.37E+07 ( 181) 1.41E+07 ( 186)  52.5  42.4  64.9   0.0   40.2  37.3  43.3
 10  1.43E+07 ( 151) 1.49E+07 ( 157)  52.5  41.7  66.1   0.0   40.6  37.6  43.7
 20  1.49E+07 ( 177) 1.53E+07 ( 182)  52.7  42.5  65.4   0.0   41.0  38.1  44.1
 17  9.67E+06 ( 102) 9.86E+06 ( 104)  53.2  40.2  70.2   0.0   41.2  38.3  44.4
 42  1.14E+07 ( 113) 1.09E+07 ( 108)  56.4  43.0  73.8   0.0   41.5  38.6  44.7
 11  1.29E+07 ( 153) 1.02E+07 ( 121)  68.8  53.9  87.9   0.0   42.1  39.2  45.3
 25  1.48E+07 ( 156) 1.01E+07 ( 107)  78.8  61.2 101.3   0.0   42.8  39.8  46.1
  6  3.26E+06 (  43) 1.90E+06 (  25)  93.3  55.9 159.2   0.0   43.1  40.0  46.3
 22  1.53E+07 ( 151) 5.67E+06 (  56) 144.9 106.2 200.6   0.0   44.1  41.0  47.4
POOL 9.46E+06( 4631) 1.17E+07( 5735)                     0.0   44.1  41.0  47.4

MEAN URANIUM CONCENTRATION +/-2SE (ppm):  457.1,  21.2

 POOLED AGE WITH 68% CONF. INTERVAL(Ma):   44.1,  42.5 --  45.7 (  -1.6   +1.7)
                95% CONF. INTERVAL(Ma):          41.0 --  47.4 (  -3.1   +3.3)
     REDUCED CHI^2, DEGREES OF FREEDOM:    5.4664,   44
                     CHI^2 PROBABILITY:    0.0%

CENTRAL AGE WITH 68% CONF. INTERVAL(Ma):   43.6,  41.2 --  46.2 (  -2.4   +2.6)
                95% CONF. INTERVAL(Ma):          39.0 --  48.8 (  -4.6   +5.2)
                    AGE DISPERSION (%):   28.7

 CHI^2 AGE WITH 68% CONF. INTERVAL (Ma):   35.8,  34.4 --  37.3 (  -1.5   +1.5)
               95% CONF. INTERVAL (Ma):          33.0 --  38.9 (  -2.8   +3.0)
       NUMBER AND PERCENTAGE OF GRAINS:   27,    60%
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==================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================

TI10-07: Orca Group Turbidite
Location: Mainland, Adjacent to Humpback Creek
GPS: N 60° 35.521′, W 145° 42.109′ SL
Etch Times: 23.75, 23.0, 20.5 hr
- Thin- to thick-bedded medium- to coarse-grained sandstone and minor interbedded shale.

DATE/TIME: 03-01-2011/14:23:48 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-07.FTZ
TI10-07A,B,C Orca Group - FEB 2011

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.096E+05
RELATIVE ERROR (%): 2.05
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U	+/-2s	Grain Age	Age (Ma) --95% CI--	
1	7.87E+06	(83)	1.41E+07	(149)	16	561	95	30.0	22.8	39.4
2	7.00E+06	(83)	9.27E+06	(110)	18	368	72	40.5	30.3	54.2
3	7.69E+06	(76)	3.84E+06	(38)	15	153	50	106.5	71.4	161.6
4	6.45E+06	(85)	8.80E+06	(116)	20	350	66	39.4	29.6	52.4
5	6.88E+06	(68)	1.29E+07	(128)	15	514	93	28.6	20.9	38.7
6	8.42E+06	(111)	8.95E+06	(118)	20	356	67	50.4	38.7	65.7
7	7.89E+06	(78)	9.00E+06	(89)	15	358	77	47.0	34.2	64.5
8	1.29E+07	(102)	1.63E+07	(129)	12	648	117	42.4	32.5	55.4
9	9.67E+06	(102)	1.25E+07	(132)	16	497	89	41.5	31.8	54.0
10	5.46E+06	(54)	6.37E+06	(63)	15	253	64	46.0	31.3	67.2
11	9.41E+06	(93)	6.07E+06	(60)	15	241	63	82.8	59.2	116.6
12	1.19E+07	(94)	1.16E+07	(92)	12	462	98	54.7	40.8	73.3
13	1.42E+07	(112)	1.85E+07	(146)	12	733	125	41.2	32.0	53.0
14	1.61E+07	(127)	1.49E+07	(118)	12	593	112	57.6	44.6	74.5
15	1.05E+07	(104)	1.25E+07	(124)	15	498	92	45.0	34.5	58.7

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2): 3.077E+05
RELATIVE ERROR (%): 2.11
EFFECTIVE URANIUM CONTENT OF MONITOR (ppm): 12.30
ZETA FACTOR AND STANDARD ERROR (yr cm^2): 347.50 8.76
SIZE OF COUNTER SQUARE (cm^2): 6.590E-07

------ GRAIN AGES IN ORIGINAL ORDER ------

Grain no.	RhoS (cm^-2)	(Ns)	RhoI (cm^-2)	(Ni)	Squares	U	+/-2s	Grain Age	Age (Ma) --95% CI--	
16	6.27E+06	(62)	1.25E+07	(124)	15	501	92	26.7	19.3	36.6
17	1.67E+07	(154)	1.38E+07	(127)	14	550	100	64.5	50.6	82.1
18	1.93E+07	(255)	2.32E+07	(306)	20	928	113	44.4	37.2	53.0
19	1.42E+06	(15)	2.09E+06	(22)	16	83	35	36.5	17.5	73.2
20	5.06E+06	(60)	4.55E+06	(54)	18	182	50	59.1	40.2	87.1
21	1.05E+07	(104)	1.09E+07	(108)	15	437	86	51.3	38.9	67.5
22	7.59E+06	(100)	9.71E+06	(128)	20	388	70	41.7	31.9	54.5
23	1.99E+06	(21)	2.37E+06	(25)	16	95	38	44.8	23.8	83.2
24	8.54E+06	(90)	9.58E+06	(101)	16	383	78	47.5	35.5	63.4
25	1.81E+07	(191)	1.62E+07	(171)	16	648	103	59.4	47.9	73.7
26	1.53E+07	(182)	8.26E+06	(98)	18	330	68	98.3	76.4	126.4
27	1.00E+07	(132)	1.87E+07	(247)	20	749	100	28.6	22.9	35.6
28	7.67E+06	(91)	7.92E+06	(94)	18	317	67	51.6	38.1	69.6
29	3.51E+06	(37)	7.11E+06	(75)	16	284	67	26.4	17.2	39.6
30	1.12E+07	(148)	7.97E+06	(105)	20	318	63	74.8	57.9	96.7

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===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:48 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-07.FTZ
TI10-07A,B,C Orca Group - FEB 2011

>>NEW PARAMETERS--ZETA METHOD<<
EFFECTIVE TRACK DENSITY FOR FLUENCE MONITOR (tracks/cm^2):      3.059E+05
                                        RELATIVE ERROR (%):      2.17
               EFFECTIVE URANIUM CONTENT OF MONITOR (ppm):     12.30
                 ZETA FACTOR AND STANDARD ERROR (yr cm^2):    347.50     8.76
                            SIZE OF COUNTER SQUARE (cm^2):      6.590E-07
------ GRAIN AGES IN ORIGINAL ORDER ------
Grain    RhoS     (Ns)      RhoI     (Ni)  Squares  U+/-2s     Grain  Age (Ma)
 no.    (cm^-2)           (cm^-2)                            Age     --95% CI--
  31   9.10E+06 (  60)  1.59E+07 ( 105)   10    641 128    30.3   21.6   42.1
  32   1.48E+07 ( 117)  1.33E+07 ( 105)   12    534 107    58.9   45.0   77.1
  33   1.56E+07 ( 164)  1.89E+07 ( 199)   16    759 112    43.7   35.2   54.2
  34   1.94E+07 ( 179)  2.16E+07 ( 199)   14    867 128    47.6   38.6   58.8
  35   5.26E+06 (  52)  1.82E+06 (  18)   15     73  34   150.9   87.6  273.6
  36   1.21E+07 ( 128)  1.21E+07 ( 128)   16    488  89    52.9   41.1   68.1
  37   2.34E+07 ( 277)  2.50E+07 ( 296)   18   1003 124    49.6   41.6   59.1
  38   2.18E+07 ( 230)  2.11E+07 ( 222)   16    847 119    54.8   45.1   66.6
  39   8.35E+06 ( 110)  1.22E+07 ( 161)   20    491  80    36.3   28.2   46.6
  40   8.67E+06 ( 120)  1.03E+07 ( 143)   21    415  72    44.5   34.6   57.1
  41   1.26E+07 ( 149)  1.21E+07 ( 143)   18    485  84    55.1   43.5   69.9
  42   2.72E+07 ( 287)  1.70E+07 ( 179)   16    683 106    84.6   69.5  102.9
  43   1.96E+07 ( 155)  1.04E+07 (  82)   12    417  94    99.4   75.7  130.5
  44   1.78E+07 ( 234)  1.97E+07 ( 259)   20    790 104    47.9   39.7   57.7
  45   1.29E+07 ( 170)  1.62E+07 ( 214)   20    653  94    42.1   34.1   52.0

===================ZetaAge Program v. 4.8 (Brandon 8/13/02)===================
DATE/TIME: 03-01-2011/14:23:48 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-07.FTZ
TI10-07A,B,C Orca Group - FEB 2011
Number of grains =  45
------ GRAIN AGES ORDERED WITH INCREASING AGE ------
Grain  RhoS    (Ns)     RhoI    (Ni)    Grain age (Ma)  P(X2)     Sum age (Ma)
 no.  (cm^-2)          (cm^-2)         Age   --95% CI--  (%)    Age    --95% CI--
 29  3.51E+06 (  37) 7.11E+06 (  75)  26.4  17.2  39.6 100.0   26.6  17.3  39.8
 16  6.27E+06 (  62) 1.25E+07 ( 124)  26.7  19.3  36.6  95.8   26.6  20.8  34.1
 27  1.00E+07 ( 132) 1.87E+07 ( 247)  28.6  22.9  35.6  90.7   27.7  23.3  32.8
  5  6.88E+06 (  68) 1.29E+07 ( 128)  28.6  20.9  38.7  97.3   27.8  23.9  32.5
  1  7.87E+06 (  83) 1.41E+07 ( 149)  30.0  22.8  39.4  97.9   28.3  24.6  32.5
 31  9.10E+06 (  60) 1.59E+07 ( 105)  30.3  21.6  42.1  98.8   28.5  25.0  32.5
 39  8.35E+06 ( 110) 1.22E+07 ( 161)  36.3  28.2  46.6  72.0   29.8  26.4  33.6
 19  1.42E+06 (  15) 2.09E+06 (  22)  36.5  17.5  73.2  77.7   29.9  26.5  33.8
  4  6.45E+06 (  85) 8.80E+06 ( 116)  39.4  29.6  52.4  51.2   30.9  27.5  34.7
  2  7.00E+06 (  83) 9.27E+06 ( 110)  40.5  30.3  54.2  32.6   31.7  28.4  35.5
 13  1.42E+07 ( 112) 1.85E+07 ( 146)  41.2  32.0  53.0  17.2   32.7  29.4  36.4
  9  9.67E+06 ( 102) 1.25E+07 ( 132)  41.5  31.8  54.0  11.2   33.5  30.2  37.1
 22  7.59E+06 ( 100) 9.71E+06 ( 128)  41.7  31.9  54.5   8.2   34.1  30.9  37.7
 45  1.29E+07 ( 170) 1.62E+07 ( 214)  42.1  34.1  52.0   4.4   35.0  31.8  38.6
  8  1.29E+07 ( 102) 1.63E+07 ( 129)  42.4  32.5  55.4   3.7   35.5  32.3  39.0
 33  1.56E+07 ( 164) 1.89E+07 ( 199)  43.7  35.2  54.2   2.1   36.3  33.1  39.7
 18  1.93E+07 ( 255) 2.32E+07 ( 306)  44.4  37.2  53.0   0.8   37.3  34.1  40.7
 40  8.67E+06 ( 120) 1.03E+07 ( 143)  44.5  34.6  57.1   0.7   37.7  34.5  41.1
 23  1.99E+06 (  21) 2.37E+06 (  25)  44.8  23.8  83.2   0.9   37.7  34.6  41.1
 15  1.05E+07 ( 104) 1.25E+07 ( 124)  45.0  34.5  58.7   0.8   38.0  34.9  41.4
 10  5.46E+06 (  54) 6.37E+06 (  63)  46.0  31.3  67.2   0.9   38.2  35.1  41.6
  7  7.89E+06 (  78) 9.00E+06 (  89)  47.0  34.2  64.5   0.9   38.5  35.4  41.9
 24  8.54E+06 (  90) 9.58E+06 ( 101)  47.5  35.5  63.4   0.7   38.8  35.7  42.2
 34  1.94E+07 ( 179) 2.16E+07 ( 199)  47.6  38.6  58.8   0.4   39.3  36.2  42.7
 44  1.78E+07 ( 234) 1.97E+07 ( 259)  47.9  39.7  57.7   0.2   40.0  36.9  43.3
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 37  2.34E+07 ( 277) 2.50E+07 ( 296)  49.6  41.6  59.1   0.0   40.7  37.6  44.1
  6  8.42E+06 ( 111) 8.95E+06 ( 118)  50.4  38.7  65.7   0.0   41.0  37.9  44.4
 21  1.05E+07 ( 104) 1.09E+07 ( 108)  51.3  38.9  67.5   0.0   41.3  38.2  44.7
 28  7.67E+06 (  91) 7.92E+06 (  94)  51.6  38.1  69.6   0.0   41.5  38.4  44.9
 36  1.21E+07 ( 128) 1.21E+07 ( 128)  52.9  41.1  68.1   0.0   41.9  38.7  45.3
 12  1.19E+07 (  94) 1.16E+07 (  92)  54.7  40.8  73.3   0.0   42.1  39.0  45.5
 38  2.18E+07 ( 230) 2.11E+07 ( 222)  54.8  45.1  66.6   0.0   42.8  39.6  46.2
 41  1.26E+07 ( 149) 1.21E+07 ( 143)  55.1  43.5  69.9   0.0   43.1  40.0  46.6
 14  1.61E+07 ( 127) 1.49E+07 ( 118)  57.6  44.6  74.5   0.0   43.5  40.3  46.9
 32  1.48E+07 ( 117) 1.33E+07 ( 105)  58.9  45.0  77.1   0.0   43.8  40.6  47.3
 20  5.06E+06 (  60) 4.55E+06 (  54)  59.1  40.2  87.1   0.0   44.0  40.8  47.4

==================ZetaAge Program v. 4.8 (Brandon 8/13/02)==================
DATE/TIME: 03-01-2011/14:23:48 FILENAME:
C:\DOCUME~1\JOHNGA~1\DESKTOP\FTFOLD~1\TYLER\UNKNOWNS\TI10-07.FTZ
TI10-07A,B,C Orca Group - FEB 2011
Number of grains =  45
------ GRAIN AGES ORDERED WITH INCREASING AGE ------
Grain  RhoS    (Ns)    RhoI    (Ni)    Grain age (Ma)  P(X2)     Sum age (Ma)
 no.  (cm^-2)         (cm^-2)         Age   --95% CI--  (%)    Age   --95% CI--
 25  1.81E+07 ( 191) 1.62E+07 ( 171)  59.4  47.9  73.7   0.0   44.5  41.3  48.0
 17  1.67E+07 ( 154) 1.38E+07 ( 127)  64.5  50.6  82.1   0.0   45.0  41.7  48.5
 30  1.12E+07 ( 148) 7.97E+06 ( 105)  74.8  57.9  96.7   0.0   45.6  42.3  49.1
 11  9.41E+06 (  93) 6.07E+06 (  60)  82.8  59.2 116.6   0.0   46.0  42.7  49.5
 42  2.72E+07 ( 287) 1.70E+07 ( 179)  84.6  69.5 102.9   0.0   47.2  43.9  50.8
 26  1.53E+07 ( 182) 8.26E+06 (  98)  98.3  76.4 126.4   0.0   48.1  44.7  51.8
 43  1.96E+07 ( 155) 1.04E+07 (  82)  99.4  75.7 130.5   0.0   48.8  45.4  52.6
  3  7.69E+06 (  76) 3.84E+06 (  38) 106.5  71.4 161.6   0.0   49.2  45.7  53.0
 35  5.26E+06 (  52) 1.82E+06 (  18) 150.9  87.6 273.6   0.0   49.5  46.0  53.3
POOL 1.13E+07( 5446) 1.22E+07( 5891)                     0.0   49.5  46.0  53.3

MEAN URANIUM CONCENTRATION +/-2SE (ppm):  486.5,  23.6

 POOLED AGE WITH 68% CONF. INTERVAL(Ma):   49.5,  47.7 --  51.4 (  -1.8   +1.9)
                 95% CONF. INTERVAL(Ma):          46.0 --  53.3 (  -3.5   +3.8)
      REDUCED CHI^2, DEGREES OF FREEDOM:    6.4027,   44
                      CHI^2 PROBABILITY:    0.0%

CENTRAL AGE WITH 68% CONF. INTERVAL(Ma):   49.6,  46.7 --  52.6 (  -2.9   +3.1)
                 95% CONF. INTERVAL(Ma):          44.0 --  55.8 (  -5.5   +6.2)
                     AGE DISPERSION (%):   31.2

 CHI^2 AGE WITH 68% CONF. INTERVAL (Ma):   36.3,  34.6 --  38.0 (  -1.7   +1.7)
                95% CONF. INTERVAL (Ma):          33.1 --  39.7 (  -3.2   +3.5)
        NUMBER AND PERCENTAGE OF GRAINS:   16,    36%
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APPENDIX D:
Track Length Data

	Grain Number	Track Length	X-position	Y-position	Angle to C-axis	Angle to X-Y	Number of Tracks on Grain
TI10-01	1	9.559	35420	63666	86.334	-4.128	1
	2	10.475	35083	64250	89.429	-1.032	2
	3	5.723	35231	64337	38.495	51.044	3
	4	6.233	35553	64365	74.753	-15.709	4
	5	9.073	36654	71613	83.617	-2.386	1
	6	6.018	36038	72060	75.084	6.147	2
	7	9.768	68332	58418	70.648	-51.934	1
	8	9.948	69644	60700	89.103	-3.888	1
	9	5.368	69934	60674	87.297	-2.083	2
	10	5.082	70040	60761	46.881	38.333	3
	11	11.678	69990	94976	62.627	-88.107	1
	12	6.919	69673	94929	88.914	63.435	2
	13	9.612	69625	121778	37.376	63.435	1
	14	7.116	69512	121820	21.604	4.456	2
	15	10.434	69256	121574	76.842	-50.782	3
	16	5.692	69465	121521	73.034	-46.975	4
	17	6.123	69573	121283	85.243	-59.184	5
	18	10.485	69922	121216	84.654	-58.595	6
	19	10.44	70051	120809	76.358	-77.583	7
	20	6.159	69997	120642	85.418	-68.523	8
	21	5.713	76192	135890	77.099	80.538	1
	22	11.294	75808	132936	56.175	0	1
	23	6.33	72599	126589	39.338	-71.03	1
	24	8.711	78170	125426	72.206	58.191	1
	25	9.082	78363	125140	72.833	18.628	1
	26	9.597	75926	96513	89.242	77.784	1
	27	7.026	75906	96888	39.698	-52.815	1
	28	7.546	75708	96688	67.126	52.001	1
	29	4.318	75830	96790	33.478	-46.79	1
	30	7.143	73871	93551	78.009	-63.768	1
	31	8.775	73916	93729	56.271	-42.397	1
	32	9.628	74086	93614	73.917	90	1
	33	4.966	74159	93815	45.623	-30.411	1
	34	10.362	74188	93822	69.375	83.83	1
	35	10.079	74327	93777	53.911	-38.246	1
	36	9.451	74089	93593	71.669	88.877	1
	37	5.85	73743	93339	81.626	-79.939	1
	38	6.861	73366	93522	88.833	-70.821	1
	39	8.547	73290	93730	51.506	70.388	1
	40	10.489	73327	93767	52.989	71.405	1
	41	5.929	73326	94023	41.598	-22.964	1
	42	5.422	73679	94221	50.043	-32.32	1
	43	7.32	73591	94301	83.02	-64.093	1

44	7.118	73903	94419	70.443	88.512	1
45	9.976	73867	94005	64.233	82.807	1
46	9.416	73959	94317	62.622	-46.591	1
47	5.349	73847	94219	81.568	-62.987	1
48	10.171	74565	84033	57.791	-82.093	1
49	6.12	74165	84438	48.402	88.264	1
50	8.236	74266	84469	82.384	-42.709	1
51	5.696	74215	84514	36.859	2.816	2
52	9.959	77783	57539	80.167	49.591	1
53	5.504	77214	57507	30.141	-82.278	1
54	5.71	77597	58040	82.291	29.055	1
55	5.605	72918	56638	73.009	-33.69	1
56	9.522	72516	55167	88.185	-27.332	1
57	10.523	78029	52238	82.84	-14.899	1
58	6.621	77971	52399	68.158	-4.028	1
59	10.563	82686	46928	79.349	-46.824	1
60	10.059	80977	53725	63.798	-43.363	1
61	9.785	81437	54060	73.923	-85.054	1
62	10.772	80395	68850	67.846	45.699	1
63	4.873	79996	68713	81.262	34.902	1
64	10.205	86902	95430	83.137	-24.228	1
65	5.516	86264	95615	43.448	14.5	1
66	10.604	83562	125063	67.801	-22.543	1
67	9.829	84987	136748	86.062	84.401	1
68	10.369	84867	136724	82.55	80.889	2
69	10.057	84949	137046	67.34	-69.001	3
70	8.852	85180	148320	75.7	59.139	1
71	9.19	91996	142478	65.783	73.644	1
72	9.448	90890	122632	79.296	38.928	1
73	9.438	90570	122531	57.847	21.371	1
74	7.453	90707	122762	36.545	-0.725	1
75	10.497	93350	110534	82.241	81.369	1
76	5.854	88591	92125	75.274	-2.816	1
77	6.669	88746	92817	84.8	17.403	1
78	4.446	90997	79780	50.853	10.84	1
79	7.162	91679	80299	67.702	66.903	1
80	6.58	89714	52000	70.992	10.521	1
81	5.358	90719	49196	50.006	6.009	1
82	10.074	90437	48933	80.651	55.548	1
83	9.208	90714	48742	71.095	64.25	1
84	6.107	91011	49216	45.62	89.105	1
85	9.804	91445	49595	80.361	39.369	1
86	10.615	91484	49561	70.907	68.102	2
87	9.288	91825	43665	76.404	52.539	1
88	7.483	92107	44304	52.681	22.457	1
89	10.082	89686	39955	88.847	61.736	1
90	7.375	89069	40301	67.731	41.326	1
91	9.275	88211	36908	84.936	-54.189	1
92	10.74	88357	37058	46.937	-6.062	2

	93	8.416	87674	36943	71.905	-29.249	1
	94	6.478	87996	37305	49.468	-7.431	1
	95	9.561	87806	37583	68.565	-27.81	1
	96	6.162	87934	37857	46.901	-6.147	2
	97	6.325	87833	37923	31.292	9.462	3
	98	9.865	87121	37934	61.833	-77.412	4
	99	5.126	98476	42873	63.887	-72.216	1
	100	10.24	96944	44523	54.86	80.623	1
	101	8.977	97105	44664	80.545	36.027	2
TI10-02	1	5.914	39433	48960	62.345	3.633	1
	2	11.223	42522	82458	81.057	-3.912	1
	3	9.082	41645	82808	74.958	-27.897	2
	4	9.07	38883	100932	87.146	1.79	1
	5	9.468	39084	100772	51.826	-33.53	2
	6	10.569	42850	109859	88.434	-12.022	1
	7	10.117	42636	109441	69.856	-30.6	2
	8	7.222	42417	110101	47.029	-53.427	3
	9	6.652	42058	110263	76.079	-24.376	4
	10	10.868	39836	113290	77.359	-46.054	1
	11	9.024	39949	113313	63.996	-84.699	2
	12	11.084	41488	132449	55.815	-21.623	1
	13	5.952	41413	132424	70.201	-7.237	2
	14	10.99	39489	148055	86.07	-68.29	1
	15	9.587	39839	147651	74.444	-87.776	2
	16	11.12	40258	147101	63.547	81.327	3
	17	9.813	42761	152148	76.003	16.484	1
	18	10.33	42875	152512	61.427	-26.086	2
	19	10.521	44310	141891	85.499	38.501	1
	20	6.906	43878	141634	78.381	22.38	2
	21	8.886	43896	141285	57.809	1.809	3
	22	7.864	50516	135551	49.805	-35.455	1
	23	7.087	50491	135145	41.336	55.685	2
	24	8.763	43982	90531	32.289	69.806	1
	25	10.25	45431	43449	89.775	6.34	1
	26	8.494	57046	31046	85.973	32.811	1
	27	6.13	55498	84131	89.616	9.605	1
	28	11.192	53347	85033	87.075	45.699	1
	29	10.059	53357	90863	80.629	-57.2	1
	30	9.245	55276	152569	83.3	47.06	1
	31	10.704	55286	152290	67.114	17.475	2
	32	8.442	55386	151911	65.849	16.209	3
	33	10.111	54843	152069	45.931	-3.708	4
	34	9.612	54671	151938	51.885	2.246	5
	35	10.977	54579	152198	71.168	21.529	6
	36	6.524	65819	162713	60.324	70.017	1
	37	9.78	65795	163154	57.897	67.59	2
	38	10.948	64056	150186	73.179	9.382	1
	39	10.741	64437	146989	66.65	80.049	1

40	6.26	61703	130566	64.199	51.072	1
41	11.707	63347	116807	76.093	51.921	1
42	9.639	62488	118711	89.694	-76.661	1
43	9.863	62450	118831	54.554	68.199	2
44	11.319	60785	86237	68.323	89.021	1
45	11.344	60792	86660	62.5	-85.156	2
46	10.241	60648	86733	61.419	-84.075	3
47	9.204	62429	81296	81.439	16.587	1
48	6.602	60717	78359	58.217	-2.454	1
49	10.972	67278	56190	31.027	-34.114	1
50	9.897	67201	55980	57.286	57.572	2
51	6.38	67470	56244	74.33	9.189	3
52	9.976	62192	50406	70.456	-88.394	1
53	11.505	60630	48197	50.889	-22.405	1
54	9.407	61189	41687	34.454	20.225	1
55	8.064	60812	41300	42.673	28.443	2
56	10.665	69900	59357	64.597	-0.498	1
57	7.548	70239	59395	68.717	3.621	2
58	7.89	73232	80031	72.123	-85.865	1
59	11.111	67611	118740	68.034	-37.833	1
60	9.757	67443	118964	72.107	-41.906	2
61	7.569	68342	120957	61.969	-22.457	1
62	9.769	69493	143000	84.302	-74.745	1
63	9.194	69583	143497	51.786	61.343	2
64	10.603	72111	163765	73.054	-83.494	1
65	6.979	75211	174139	43.162	27.613	1
66	10.762	75195	174163	85.661	78.789	2
67	7.022	77045	155790	86.238	1.507	1
68	6.76	77348	155577	57.791	-26.94	2
69	10.471	83245	88944	83.047	28.264	1
70	11.042	80622	74565	62.15	40.888	1
71	10.253	80737	74767	85.187	73.551	2
72	11.135	80516	74092	71.768	50.505	4
73	5.95	78452	62116	83.864	13.815	1
74	10.469	79130	62163	56.441	-25.88	2
75	8.712	80242	56352	84.114	-83.032	1
76	5.857	78137	56943	88.399	3.814	1
77	10.39	83270	57179	89.408	-27.255	1
78	8.015	83969	80665	67.619	2.793	1
79	10.222	83533	80894	75.46	-34.129	2
80	10.936	83489	80983	87.298	-16.887	3
81	11.88	83317	81079	71.355	-38.234	4
82	11.226	89249	155885	67.576	45.347	1
83	10.253	87062	161415	86.28	71.395	1
84	11.072	98216	82931	36.518	-1.958	1
85	5.681	98436	82910	54.812	16.336	2
86	11.821	96749	74332	70.566	52.75	1
87	11.137	98605	71753	72.497	2.406	1
88	9.843	98806	71996	78.019	31.891	2

	89	10.904	98446	72095	42.342	67.567	3
	90	11.569	102506	63944	53.052	19.026	1
	91	10.768	103758	70398	70.449	70.907	1
	92	8.402	103098	70511	52.836	14.191	2
	93	10.508	102960	70252	72.769	68.587	3
	94	6.863	113444	136774	34.158	-30.7	1
	95	11.206	112571	73829	59.249	51.789	1
	96	10.951	112684	73601	81.423	29.615	2
	97	10.512	114005	72557	77.623	-17.475	1
	98	9.156	114061	72846	75.276	-44.576	2
	99	8.827	112169	72430	55.946	-11.434	1
	100	9.359	111698	72284	89.954	22.574	2
	101	9.733	111759	72692	72.979	5.599	3
	102	11.523	111457	65098	43.68	37.569	1
	103	9.358	119114	58776	59.308	-0.579	1
	104	10.875	119022	58812	52.72	6.009	2
	105	9.544	119372	134373	58.047	25.32	1
	106	10.736	131589	120379	75.518	81.573	1
	107	10.097	126591	83711	74.985	31.149	1
	108	10.797	127520	83872	41.575	64.558	2
	109	10.858	136035	109348	75.893	31.9	1
	110	9.806	136034	109348	73.028	33.69	1
	111	10.166	136031	109239	85.072	45.735	2
	112	10.676	144409	84607	84.214	2.49	1
	113	10.535	158364	101384	88.939	-35.952	1
	114	11.09	158043	101242	58.189	-68.824	2
TI10-03	1	10.522	48493	87985	72.561	-0.521	1
	2	10.479	48653	87644	78.499	-6.459	2
	3	10.065	48577	88212	82.11	-10.069	3
	4	9.706	49091	111167	84.195	-19.316	1
	5	9.417	49020	111343	79.207	-24.305	2
	6	6.338	49059	111520	63.275	-40.236	3
	7	9.344	59564	133994	79.048	31.264	1
	8	9.751	59636	134236	73.859	26.075	2
	9	6.187	59956	134119	70.869	23.085	3
	10	10.901	60270	134446	73.478	25.694	4
	11	10.729	74397	132326	83.06	81.444	1
	12	9.249	73698	72503	61.767	-88.282	1
	13	5.433	74070	72658	73.268	80.218	2
	14	9.507	70453	57555	86.224	49.399	1
	15	9.875	70168	57603	83.594	52.028	2
	16	9.302	70563	57895	78.358	57.265	3
	17	9.078	70622	58004	87.305	48.318	4
	18	11.236	70703	58132	86.364	41.987	5
	19	6.486	75463	56656	79.171	89.182	1
	20	4.874	75599	56542	84.627	72.979	2
	21	7.009	75675	56572	89.356	78.996	3
	22	9.567	75966	51912	83.031	-83.224	1

23	8.644	75960	51917	59.982	59.789	2
24	8.297	75685	52468	78.372	78.179	3
25	10.494	79976	59255	60.438	-19.759	1
26	10.065	80630	59070	87.56	12.242	2
27	6.368	78336	65490	81.066	-71.834	1
28	7.348	78414	65858	83.41	-56.31	2
29	9.309	78312	65870	83.249	-56.149	3
30	5.49	78184	65817	34.133	61.232	4
31	9.129	78084	65673	83.729	-69.171	5
32	9.807	78024	65508	86.976	-65.925	6
33	10.094	81650	124584	69.667	3.151	1
34	10.842	81822	124599	73.308	-0.49	2
35	5.913	81884	124502	66.376	6.442	3
36	9.851	81441	124440	78.616	-28.566	4
37	6.083	91145	69676	85.491	56.31	1
38	5.82	91232	69592	59.88	-89.061	2
39	10.381	90981	69675	63.495	87.325	3
40	10.759	85171	65365	69.124	89.479	1
41	7.612	95346	67880	88.753	-33.887	1
42	10.795	99579	70020	89.724	-89.484	1
43	11.235	99469	70391	89.76	90	2
44	9.251	99350	70280	59.204	59.444	3
45	7.469	99402	69627	73.412	73.652	4
46	9.044	99948	70135	27.336	-27.096	5
47	9.719	104471	75213	57.948	31.35	1
48	9.603	112170	67399	63.541	66.949	1
49	9.032	112211	67262	72.843	76.251	2
50	5.81	114847	81731	82.42	-40.4	1
51	9.347	114665	81856	79.796	-37.776	2
52	6.716	115033	81148	78.121	-59.859	3
53	10.113	114982	81372	63.134	-21.114	4
54	4.621	114492	81611	50.27	-87.709	5
55	6.222	115395	87411	88.159	6.34	1
56	6.252	115243	87463	61.355	-24.146	2
57	10.007	115718	87871	63.627	30.872	3
58	7.243	115817	87470	46.873	47.626	4
59	11.71	116339	87737	20.02	-65.48	6
60	11.11	112086	112513	63.733	-71.727	1
61	11.26	112178	112463	77.721	69.727	2
62	5.399	112415	112380	86.48	78.486	3
63	9.435	112557	112695	78.538	-86.532	4
64	10.339	112380	112958	35.945	27.951	5
65	10.614	112503	113024	65.015	-73.009	6
66	11.429	116967	61403	57.547	46.317	1
67	9.83	116662	62249	78.77	90	2
68	7.677	116269	61132	57.235	46.005	3
69	10.817	127988	74848	73.718	-55.049	1
70	9.562	129086	78012	84.053	-44.605	1
71	6.529	142985	39211	89.349	-49.044	1

	72	8.401	128766	83945	49.619	-39.89	1
	73	6.08	128500	84059	58.858	-30.651	2
	74	10.715	127045	76217	68.235	-19.938	1
	75	10.667	128535	76729	83.288	-46.824	1
	76	6.939	128341	76679	88.522	-52.058	2
	77	10.73	128647	77292	68.305	-75.231	3
	78	9.537	129099	77993	82.578	-42.158	1
	79	6.545	129404	77445	45.39	-4.97	2
	80	9.251	125474	78620	84.725	47.49	1
	81	9.214	125419	78628	61.948	70.267	2
	82	6.284	125494	79714	79.263	0	1
	83	10.983	125949	79864	66.16	13.103	2
	84	10.253	126298	79870	81.643	-19.093	3
	85	8.713	128776	83952	51.002	-39.333	1
	86	6.042	128508	84056	57.864	-32.471	2
	87	6.815	125727	87057	41.597	18.178	1
	88	10.775	132324	100634	47.807	34.824	1
	89	10.011	132231	100687	62.139	20.493	2
	90	10.605	132289	100747	74.502	8.13	3
	91	6.32	132001	100898	51.175	-46.193	4
	92	6.915	144038	137574	88.058	-68.499	1
	93	5.684	144207	137869	70.748	-51.189	2
	94	6.562	144189	138012	35.848	55.408	3
	95	11.366	140796	136779	78.467	12.995	1
	96	10.112	143482	103545	57.746	-83.073	1
	97	6.632	143639	103709	66.862	-27.681	2
	98	11.431	148185	67133	62.359	72.759	1
	99	10.755	148492	82867	83.546	-45	1
	100	9.324	150014	83436	83.498	26.053	1
	101	8.607	149375	83368	73.088	49.467	2
	102	10.174	149207	104517	86.163	-32.115	1
TI10-04	1	10.438	30721	74706	64.393	8.202	1
	2	11.123	30814	27639	70.904	-30.713	1
	3	9.856	30681	27594	88.501	-13.116	2
	4	11.12	31010	27711	88.474	-10.091	3
	5	6.771	31045	27566	34.298	-67.319	4
	6	10.28	31008	27389	43.398	-58.219	5
	7	10.395	30827	27074	70.653	-30.964	6
	8	9.597	30567	27543	37.438	-64.179	7
	9	10.054	30346	27836	75.052	-26.565	8
	10	8.355	30283	27641	43.351	-58.266	9
	11	10.225	46385	106246	73.81	-28.195	1
	12	10.733	46157	71029	71.932	12.693	1
	13	9.755	46410	70847	60.775	23.85	2
	14	11.053	46586	70974	67.074	-28.301	3
	15	10.589	53951	40968	73.659	-43.568	1
	16	9.156	56454	127388	88.389	39.579	1
	17	9.138	63037	123059	53.985	85.333	1

18	7.238	62736	122954	62.186	-30.838	2
19	10.951	63614	119667	63.079	-52.038	1
20	6.275	63704	120118	74.853	-63.812	2
21	9.176	63630	119554	60.127	-49.086	3
22	5.167	64889	96411	66.767	88.939	1
23	7.737	64819	96880	78.483	-56.31	2
24	4.934	64922	96821	49.725	-27.553	3
25	10.851	64105	93025	44.918	-9.545	1
26	9.757	64002	92649	80.944	-63.682	2
27	10.452	69732	88595	83.722	-51.18	1
28	7.527	69723	88416	50.03	-84.872	2
29	11.664	69633	88362	66.703	-68.199	3
30	9.281	69136	105759	76.009	21.915	1
31	8.902	68906	105990	88.762	9.162	2
32	9.912	65158	146844	66.284	-21.801	1
33	9.99	65344	147260	75.676	16.239	2
34	6.515	65374	147138	45.213	46.701	3
35	10.115	65161	147165	60.301	-27.784	4
36	5.576	65196	147376	53.103	38.811	5
37	11.239	79135	131349	88.541	19.335	1
38	10.816	79101	131423	62.265	-6.941	2
39	9.534	78948	131320	77.104	33.69	3
40	10.095	75721	125487	68.862	-59.4	1
41	10.837	85428	30186	59.662	47.095	1
42	5.966	85349	30340	84.372	11.129	2
43	5.429	85584	30444	79.317	27.44	3
44	11.065	92941	120782	66.992	4.325	1
45	7.773	93052	120698	82.491	-11.174	2
46	10.612	93049	120484	73.564	-35.119	3
47	8.912	92782	120481	68.956	-39.726	4
48	11.19	92258	120721	38.554	32.764	5
49	6.752	93955	87015	55.736	16.928	1
50	10.228	104391	81803	79.729	-73.761	1
51	11.61	104476	81611	52.441	-25.931	2
52	9.761	103843	81437	87.843	-65.647	3
53	9.289	97631	117142	63.262	-28.887	1
54	5.862	97782	117160	63.332	24.52	2
55	10.856	111186	135999	84.173	41.76	1
56	10.046	111482	136157	64.214	21.801	2
57	10.504	111542	136355	55.353	82.235	3
58	10.942	111618	136132	81.947	55.641	4
59	10.702	111686	136141	76.514	34.101	5
60	9.943	107243	87850	59.349	-29.876	1
61	9.783	107180	87811	78.024	-48.552	2
62	9.216	104596	88207	35.804	-46.236	2
63	9.308	104745	88608	68.701	-13.339	3
64	5.472	104777	88460	55.028	-27.013	4
65	5.621	104764	88221	52.96	45	5
66	4.986	100414	98110	62.541	72.255	1

	67	9.314	103633	97799	88.25	14.036	1
	68	6.165	103673	97838	75.096	0.881	2
	69	9.501	103785	97986	79.813	5.599	3
	70	4.39	104001	97762	48.447	57.339	4
	71	9.509	104092	97641	59.967	45.818	5
	72	5.494	105927	104950	59.285	58.707	1
	73	10.81	105952	104704	66.717	66.14	2
	74	9.785	100345	116949	34.626	-87.166	1
	75	4.408	100442	117110	69.067	58.392	2
	76	9.594	100090	117223	54.269	73.191	3
	77	5.813	100542	117135	65.697	61.763	4
	78	10.519	103314	122317	72.412	75.71	1
	79	9.097	103240	122338	56.194	-52.896	2
	80	4.904	102984	122407	58.179	61.477	3
	81	10.342	112927	119205	65.673	-88.939	1
	82	8.272	112633	119276	54.073	79.461	2
	83	9.346	113078	118953	84.719	-59.331	3
	84	11.389	114466	115825	30.51	-31.799	1
	85	5.615	114227	116067	44.267	42.979	2
	86	9.879	114220	116156	73.026	71.737	4
	87	10.719	115039	115111	75.03	-81.215	1
	88	9.658	114748	115089	80.523	-56.768	2
	89	10.385	113960	114495	67.561	5.659	1
	90	6.047	114930	112249	65.025	14.47	1
	91	10.591	116839	110084	46.728	-31.842	1
	92	9.062	117316	109987	65.892	35.538	2
	93	5.484	117291	109872	58.587	-19.983	3
	94	6.041	111420	96215	89.193	-49.399	1
	95	5.354	118516	88389	64.569	7.125	1
	96	2.76	118753	88384	79.057	-29.249	2
	97	6.181	112165	81738	75.715	53.31	1
	98	5.445	111828	81803	41.03	-63.435	2
	99	3.913	111880	82114	71.78	85.815	3
	100	10.793	112012	82155	70.197	47.793	4
	101	5.635	111817	81786	44.021	-66.425	5
	102	7.122	111812	81759	58.623	-81.027	6
	103	5.66	113773	82049	45.511	-47.726	1
	104	5.206	113531	82086	83.583	3.18	2
	105	4.261	111131	64497	84.437	-10.081	1
	106	6.309	111508	64120	36.269	49.214	2
	107	9.028	111392	63783	75.014	10.469	3
	108	7.012	111237	63803	78.353	-16.164	4
TI10-05	1	7.02	59481	94993	54.421	-64.134	1
	2	3.041	62777	92613	71.893	-18.435	1
	3	11.08	62378	92762	89.672	0	2
	4	4.554	62367	92466	85.464	-4.865	3
	5	3.753	62230	92501	75.585	-14.744	4
	6	11.422	61995	92391	46.345	-43.983	5

7	10.763	70877	110866	84.795	71.25	1
8	10.823	70908	110404	58.193	44.648	2
9	11.37	70933	143552	80.75	-23.86	1
10	6.671	76576	144449	86.086	-56.083	1
11	12.086	76627	144224	74.136	-68.033	2
12	12.592	75868	140615	11.53	-58.092	1
13	4.422	72943	137288	70.674	51.911	1
14	7.069	72885	137388	57.011	-75.774	2
15	10.374	72800	137421	84.508	76.729	3
16	8.762	72591	137280	40.334	21.571	4
17	10.3	72985	137003	82.341	78.896	5
18	8.297	73427	137377	47.943	29.181	6
19	4.369	77590	93129	85.245	71.175	1
20	9.936	77808	93475	74.55	81.87	2
21	9.837	80276	68793	81.909	52.907	1
22	8	83548	88234	78.666	15.195	1
23	5.838	83390	88304	39.413	-24.057	2
24	10.489	83139	88129	40.82	75.71	3
25	6.286	88535	167826	85.114	19.767	1
26	8.157	94753	162861	47.536	11.957	1
27	9.037	95046	162600	80.188	-20.695	2
28	9.728	97134	84651	71.078	-68.199	1
29	9.552	97148	84856	88.566	-50.711	2
30	7.392	112940	79234	78.3	2.936	1
31	8.695	129184	118292	50.875	71.365	1
32	9.089	129559	118101	56.518	-36.027	2
33	6.905	129586	117993	47.26	67.751	3
34	6.027	143729	127246	77.762	-8.531	1
35	4.77	143672	127346	73.385	-12.907	2
36	6.938	143461	127391	82.32	-3.972	3
1	8.112	30733	42907	70.228	51.953	1
2	6.189	30426	66366	40.972	-29.638	1
3	6.802	30501	66338	74.418	-63.083	2
4	11.329	30626	66692	72.534	83.868	3
5	8.476	58598	120246	77.16	-86.228	1
6	11.297	55781	78708	84.541	1.958	1
7	11.963	66823	72631	74.05	52.842	1
8	6.722	63433	132803	66.22	-48.366	1
9	5.733	70768	119667	73.908	-65.556	1
10	3.365	74273	75234	56.301	71.565	1
11	8.352	73978	75408	89.754	-74.982	2
12	4.686	73870	75411	77.225	-87.51	3
13	7.478	74336	75468	70.446	85.711	4
14	4.977	74384	75661	75.837	-88.898	5
15	10.816	87370	50262	77.031	-65.298	1
16	7.926	96288	63298	79.533	61.607	1
17	6.531	97995	120748	88.643	50.194	1
18	6.266	98026	120688	80.436	41.987	2
19	5.985	98024	120406	89.505	52.046	3

20	11.295	99167	122579	89.246	85.156	1
21	9.309	109615	99121	74.133	-46.219	1
22	7.737	109173	99318	88.369	-28.72	2
23	10.454	107235	96716	65.931	4.677	1
24	10.76	107353	97150	81.149	19.895	2
25	6.258	107112	96948	79.689	18.435	3
26	9.99	113171	90044	59.459	52.267	1
1	7.661	34743	87309	46.657	-24.386	1
2	8.55	34858	87481	60.802	48.155	2
3	5.499	42777	101252	64.172	-14.281	1
4	10.031	47519	101723	65.048	72.979	1
5	8.666	53225	113020	88.061	-65.973	1
6	11.8	53264	131486	77.238	-9.982	1
7	10.506	52900	131313	79.123	13.658	2
8	10.705	52860	131302	43.106	49.674	3
9	11.526	60994	110308	52.031	82.933	1
10	10.507	56833	98525	81.288	3.576	1
11	11.475	56908	98495	76.7	-18.435	2
12	8.653	69095	48049	43.117	-67.855	1
13	10.352	63128	107163	59.757	-26.328	1
14	10.422	68762	142805	69.479	-70.062	1
15	6.505	68744	143315	55.257	-55.84	3
16	9.085	74643	118898	71.004	26.301	1
17	8.052	75482	115912	88.55	-74.805	1
18	5.978	75663	115871	64.412	78.158	2
19	8.989	75770	115504	84.128	-82.126	3
20	9.912	75664	115377	81.8	-84.455	4
21	7.748	73604	101980	39.505	52.853	1
22	11.683	71015	100827	77.202	-6.082	1
23	10.412	70882	100831	69.269	-39.611	2
24	11.483	79642	71830	71.682	39.094	1
25	9.759	83243	97128	88.732	-0.551	1
26	11.421	83544	132591	83.418	20.726	1
27	10.747	83737	132528	42.275	61.869	2
28	11.201	83697	132174	84.753	8.896	3
29	11.687	83318	132213	85.397	9.54	4
30	6.973	82885	131926	63.717	40.426	5
31	11.279	82185	131840	56.816	-19.041	6
32	10.4	82125	131836	71.093	-4.764	7
33	8.791	77770	150474	72.515	-24.692	1
34	9.08	77726	150508	61.755	21.038	2
35	10.674	77973	150398	70.264	12.529	3
36	7.65	82315	162219	86.141	82.786	1
37	5.887	89774	156258	74.178	-54.782	1
38	7.562	89599	156277	87.916	-72.688	2
39	5.955	89475	156127	57.763	-38.367	3
40	11.537	89476	155818	63.015	-43.62	4
41	12.174	89822	155506	46.642	66.038	6
42	9.695	91950	110640	73.418	-68.607	1

	43	6.401	91791	110428	88.527	-53.499	2
	44	11.432	92222	110279	81	-43.025	3
	45	9.721	92012	109988	44.832	82.807	4
	46	7.988	89546	85950	86.569	-44.045	1
	47	7.885	89342	86432	82.303	-48.311	2
	48	10.832	87282	82612	57.219	-38.047	1
	49	9.097	86275	82578	66.856	17.879	2
	50	10.285	86031	82641	62.918	-32.347	3
	51	6.25	86435	82689	88.256	-3.521	5
TI10-06	1	7.983	35152	136822	70.131	48.424	1
	2	5.877	35674	137344	50.762	29.055	2
	3	7.818	50269	98617	78.895	30.256	1
	4	4.819	49437	104269	53.942	-56.004	1
	5	6.995	49385	104361	47.254	-49.316	2
	6	8.36	49570	104087	59.988	57.926	3
	7	9.613	49604	104571	74.876	72.814	4
	8	9.143	56737	134211	51.065	4.865	1
	9	6.843	56563	134349	54.107	7.907	2
	10	9.855	56644	134369	52.181	5.981	3
	11	10.1	55166	117762	48.57	-2.102	1
	12	9.583	55127	117941	80.624	-52.907	2
	13	11.124	55773	117243	81.742	-51.789	3
	14	10.515	50406	115404	69.781	-73.156	1
	15	10.107	50766	115577	73.757	70.382	2
	16	6.604	54756	115359	57.266	21.501	1
	17	11.201	55552	114580	73.057	5.711	2
	18	6.902	56085	115440	56.207	69.075	1
	19	5.642	51324	110728	53.612	26.996	1
	20	9.963	56728	110393	56.495	47.654	1
	21	8.593	56855	110335	83.295	20.854	2
	22	9.326	56473	110475	66.122	38.027	3
	23	6.132	52344	100079	69.197	-3.576	1
	24	7.349	56316	85933	88.623	-49.086	1
	25	8.374	56319	86176	67.661	-72.801	2
	26	4.935	56031	86123	71.019	-69.444	3
	27	11.369	56149	85772	75.184	-35.647	4
	28	10.695	57372	77145	88.521	76.088	1
	29	10.998	57427	77246	89.832	77.735	2
	30	7.816	59753	53196	77.321	17.354	1
	31	9.936	60957	59246	78.754	47.654	1
	32	8.059	60932	59364	80.863	49.764	2
	33	8.491	60963	58700	82.099	66.801	3
	34	9.226	60407	66255	79.806	-11.889	1
	35	11.276	60477	66208	87.877	-24.206	2
	36	10.536	64778	68303	49.602	-33.111	1
	37	9.676	61878	69233	88.588	26.065	1
	38	6.121	62152	69340	37.135	-25.388	2
	39	10.25	63056	79920	50.773	-46.528	1

40	4.904	63552	80421	56.219	-41.082	2
41	9.797	65040	95615	85.026	-40.365	1
42	9.543	65682	95484	62.579	-7.97	2
43	8.237	62590	96562	87.922	-28.926	1
44	10.881	63432	96390	80.182	-17.03	2
45	8.609	63468	96211	89.994	-26.854	3
46	5.858	62186	97488	57.498	52.943	1
47	9.842	62330	97294	38.499	-31.059	2
48	9.726	62388	97728	74.011	36.431	3
49	10.348	65809	107920	81.432	-54.462	1
50	7.868	65422	115615	43.09	-36.591	1
51	7.742	65447	115584	75.861	-69.362	2
52	11.091	60512	129750	88.588	39.999	1
53	10.361	60628	129688	77.424	28.836	2
54	11.345	59902	144324	74.387	-51.415	1
55	11.023	65459	148479	72.001	-3.424	1
56	10.434	65480	148559	83.111	-14.534	2
57	10.947	73967	162978	76.616	70.925	1
58	7.956	74418	152354	78.689	68.575	1
59	9.132	69737	131494	89.63	67.977	1
60	9.922	73191	126550	85.086	56.646	1
61	10.433	73846	124846	81.778	74.792	1
62	9.028	73882	124335	75.583	-82.569	2
63	10.31	72626	123478	61.792	-64.604	1
64	9.183	72836	123454	72.413	-75.225	2
65	9.725	72458	123919	76.485	73.673	3
66	10.526	72834	123839	50.737	-53.549	4
67	10.203	72699	124464	76.062	73.25	5
68	10.589	66642	124316	41.379	21.501	1
69	10.074	66704	124550	89.07	69.193	2
70	7.984	66860	124404	50.343	30.466	3
71	10.347	66571	125070	73.426	53.549	4
72	10.15	72419	122734	85.121	-70.907	1
73	8.257	72606	122416	62.738	-38.766	2
74	8.843	72663	122295	62.061	-38.089	3
75	10.311	72348	122241	58.641	82.614	4
76	5.317	72390	120172	74.529	-16.091	1
77	7.726	67980	111539	67.245	12.836	1
78	8.499	68245	111780	55.413	70.178	2
79	5.035	68368	111635	54.409	0	3
80	10.254	69399	80160	78.189	65.336	1
81	10.492	67931	79052	81.694	71.405	1
82	6.358	68090	79059	64.262	53.973	2
83	9.742	66983	75644	79.193	-19.983	1
84	11.834	69289	58831	65.435	33.299	2
85	10.806	70404	58692	89.138	54.758	1
86	11.754	71302	57092	85.682	81.539	1
87	11.244	80147	51888	57.708	-52.66	1
88	9.184	81990	52284	58.749	-1.753	1

	89	9.377	74656	70350	59.962	-29.887	1
	90	9.898	74751	70327	71.888	18.263	2
	91	5.897	78959	79912	88.342	31.122	1
	92	11.033	78901	80131	49.737	69.727	2
	93	9.166	78754	80140	59.366	-1.169	3
	94	8.473	78470	91368	65.131	77.053	1
	95	7.683	77140	93263	66.005	-78.003	1
	96	10.524	76479	107760	56.025	23.344	1
	97	11.859	74980	125230	83.013	80.154	1
	98	10.925	75945	125799	79.269	77.307	1
	99	9.476	76029	125889	76.808	74.846	2
	100	8.893	75899	125961	47.306	-49.268	3
	101	7.229	75846	125624	47.497	45.535	4
	102	10.275	80524	124717	62.016	38.911	1
	103	8.038	79860	128220	68.431	42.553	1
	104	9.273	79151	129127	78.719	-48.814	1
	105	8.806	79425	129830	53.678	-23.772	2
	106	8.372	77471	132991	57.169	7.679	1
	107	10.668	77663	133225	78.78	51.73	2
TI10-07	1	7.324	49838	86939	79.985	-36.135	1
	2	6.501	49796	86945	54.533	-61.587	2
	3	7.052	49540	86727	71.12	-45	3
	4	8.082	49785	94951	53.452	73.496	1
	5	11.398	55746	110157	68.133	-64.306	1
	6	9.799	56397	110104	62.387	-14.826	2
	7	7.129	59884	65161	73.414	90	1
	8	10.792	59768	65222	77.976	61.39	2
	9	10.083	59918	65593	42.947	-61.518	1
	10	9.083	62047	72823	77.577	-41.241	1
	11	11.617	61382	76742	71.178	84.015	1
	12	10.625	63217	86233	86.936	70.735	1
	13	10.709	63653	85917	48.357	-64.558	2
	14	11.124	59186	85352	85.625	5.281	1
	15	4.649	66152	89345	73.17	-77.989	1
	16	11.328	66058	89695	86.145	81.327	2
	17	10.831	66339	89584	46.055	41.236	3
	18	9.245	62295	113345	71.341	-87.138	1
	19	9.972	62309	112833	63.065	-41.543	2
	20	7.196	63830	115091	79.183	-3.013	1
	21	7.44	63964	114909	52.297	45.507	2
	22	10.783	64092	116255	85.777	42.138	1
	23	10.357	70454	135203	70.116	46.824	1
	24	11.863	70638	135486	82.361	34.579	2
	25	10.344	67678	117475	76.242	61.595	1
	26	9.52	68669	81879	82.016	76.504	1
	27	5.738	68527	81673	81.012	75.5	2
	28	10.002	73853	79422	77.276	-20.493	2
	29	5.763	69756	38311	61.793	-57.381	1

30	10.034	80613	49088	59.755	4.808	1
31	6.524	80491	49169	85.88	39.174	2
32	9.683	80881	49179	88.798	33.851	3
33	11.094	78229	54989	53.813	42.51	1
34	9.563	78229	54828	72.075	60.772	2
35	9.973	81577	60311	89.386	37.082	1
36	10.317	81627	60330	65.648	62.049	2
37	10.323	77652	65467	46.089	2.701	1
38	7.826	77695	65929	73.945	-57.265	2
39	5.196	78036	65610	48.463	-82.747	3
40	10.423	75493	80397	67.08	13.908	1
41	4.312	79724	101739	89.846	-37.875	1
42	10.865	79481	101857	71.826	-19.855	2
43	11.268	79197	101850	53.849	-1.878	3
44	10.503	75853	101510	64.324	16.65	1
45	5.589	74884	102514	54.013	-1.975	1
46	7.757	75335	102619	86.013	37.999	2
47	9.849	79745	102761	53.568	17.723	1
48	11.87	76037	106360	57.687	58.805	1
49	9.663	76445	116766	66.019	43.831	1
50	8.559	76545	116801	41.823	-64.011	2
51	5.095	78023	120347	78.535	1.042	1
52	9.95	77870	120355	42.602	-57.821	2
53	6.033	88985	155931	72.536	-10.954	1
54	8.516	88677	147974	58.51	86.228	1
55	9.86	88726	147927	60.121	87.839	2
56	11.911	85402	113240	88.409	-58.805	1
57	11.913	88482	110223	68.886	-10.869	1
58	11.047	88512	110256	66.287	33.959	2
59	8.569	82860	91393	71.686	33.518	1
60	10.83	88674	42916	56.025	15.301	1
61	8.855	89012	43772	81.91	41.186	2
62	9.885	84124	42241	78.104	-46.528	1
63	11.294	96538	37589	71.871	65.596	1
64	11.132	96600	37960	61.105	-67.38	2
65	11.095	96826	37284	63.914	57.639	3
66	9.266	96024	42764	34.294	-72.121	1
67	7.789	95792	42809	87.092	-19.323	2
68	10.332	95420	42933	89.912	-16.327	3
69	10.632	96466	42972	49.396	-57.019	4
70	7.307	96406	42824	42.322	-64.093	5
71	10.573	91675	71311	71.71	2.027	1
72	9.816	91995	73249	28.911	-18.789	1
73	9.584	97880	81692	80.042	28.566	1
74	8.9	94027	107841	69.76	36.989	1
75	10.37	96082	117941	56.485	42.274	1
76	10.173	96211	120401	72.237	67.42	1
77	9.228	96300	120486	86.919	88.264	2
78	10.707	96503	120416	74.879	-79.695	3

79	8.045	95314	134567	73.513	90	1
80	10.564	95244	134514	65.942	-49.456	2
81	5.288	95310	134354	65.524	82.011	3
82	7.056	95649	134008	84.226	-79.287	4
83	10.403	95272	133901	47.626	-31.139	5
84	9.569	92828	150813	86.841	5.711	1
85	10.221	93041	150565	44.218	54.652	2
86	6.782	92445	152083	83.733	-40.006	1
87	5.271	96897	154241	62.393	-14.534	1
88	7.096	96998	154046	47.074	0.785	2
89	5.686	96738	154253	77.007	-29.148	3
90	9.786	92651	156976	83.272	-80.716	1
91	10.086	91667	156625	75.397	10.105	1
92	11.486	91831	156911	70.783	14.72	2
93	8.111	91594	157086	79.821	-14.676	3
94	9.96	98872	159058	58.927	37.733	1
95	9.078	102280	148666	79.929	31.569	1
96	11.305	104801	148125	71.969	-24.011	1
97	11.01	104877	148136	64.238	-16.28	2
98	6.511	104937	148063	55.282	-76.759	3
99	8.944	99200	118267	83.764	-49.658	1
100	9.395	102949	113201	70.137	-29.11	1
101	7.596	100139	104067	47.249	-9.926	1
102	10.889	101735	65105	66.135	-8.556	1
103	9.452	98918	63883	80.732	-88.877	1
104	4.829	104823	56172	71.205	-37.972	1

APPENDIX E:

Raman Spectroscopy Data

TI10-7 - Raw data of Raman Spectroscopy

Mt	Grain	V_3SiO_4	hwhm	V_1SiO_4	hwhm	V_3SiO_4	Stdv	hwhm	Stdv	V_1SiO_4	Stdv	hwhm	Stdv
A	18b	1007.537	3.294	974.236	3.694								
A	18c	1007.413	3.810	974.057	4.691								
A	18d	1007.645	3.430	974.342	3.712			grain average					
A	18e	1007.644	3.226	974.296	3.254	1007.560	0.11	3.440	0.26	974.233	0.12	3.838	0.61
A	60a	1007.825	3.078	974.360	3.230								
A	60b	1007.787	2.988	974.325	3.217								
A	60c	1007.806	3.175	974.326	3.218			grain average					
A	60d	1007.777	3.089	974.329	3.137	1007.799	0.02	3.083	0.08	974.335	0.02	3.201	0.04
A	61a	1007.290	3.022	974.200	3.750								
A	61b	1007.111	3.076	973.700	3.500								
A	61c	1007.337	3.906	974.200	3.538			grain average					
A	61d	1007.292	3.621	974.208	3.283	1007.258	0.10	3.406	0.43	974.077	0.25	3.518	0.19
A	64a	1007.872	3.380	975.055	4.036								
A	64b	1007.715	3.015	974.445	2.266								
A	64c	1007.860	2.521	974.438	2.335			grain average					
A	64d	1008.025	3.675	974.468	3.526	1007.868	0.13	3.148	0.50	974.602	0.30	3.041	0.88
A	69a	1007.321	3.345	973.836	2.801								
A	69b	1007.222	3.394	973.683	2.586								
A	69c	1007.071	3.185	973.656	2.347			grain average					
A	69d	1007.249	2.993	973.999	2.546	1007.216	0.11	3.229	0.18	973.794	0.16	2.570	0.19
A	70a	1007.537	2.927	974.041	2.877								
A	70b	1007.482	2.823	974.023	2.662								
A	70c	1007.589	3.021	974.241	3.426			grain average					
A	70d	1007.607	2.947	974.358	3.431	1007.554	0.06	2.930	0.08	974.166	0.16	3.099	0.39
A	72a	1007.359	3.154	973.900	2.772								
A	72b	1007.276	3.066	973.827	2.534								
A	72c	1007.402	3.161	974.030	2.580			grain average					
A	72d	1007.378	3.133	973.959	2.561	1007.354	0.05	3.129	0.04	973.929	0.09	2.612	0.11
A	73a	1007.401	2.994	974.186	2.689								
A	73b	1007.377	3.114	974.095	2.783								
A	73c	1007.472	2.909	974.048	2.749			grain average					
A	73d	1007.363	2.957	975.064	2.743	1007.403	0.05	2.994	0.09	974.348	0.48	2.741	0.04
A	76a	1007.817	2.779	974.331	2.446								
A	76b	1007.768	2.842	974.297	2.497								
A	76c	1007.805	2.851	974.364	2.522			grain average					
A	76d	1007.799	2.791	974.325	2.512	1007.797	0.02	2.816	0.04	974.329	0.03	2.494	0.03
A	79a	1007.569	3.015	974.331	2.599								
A	79b	1007.562	2.970	974.122	2.583								
A	79c	1007.576	2.987	974.115	2.607			grain average					
A	79d	1007.570	3.057	974.027	2.651	1007.569	0.01	3.007	0.04	974.149	0.13	2.610	0.03
A	102a	1007.284	3.510	974.143	4.532								
A	102b	1007.379	3.291	973.985	2.829								
A	102c	1007.336	3.465	974.059	4.039			grain average					
A	102d	1007.172	3.276	973.837	2.593	1007.293	0.09	3.386	0.12	974.006	0.13	3.498	0.94
A	106a	1007.437	3.189	974.123	3.471								
A	106b	1007.427	3.209	974.133	3.585								

A	106c	1007.333	3.367	974.116	3.908			grain average					
A	106d	1007.322	3.192	974.118	3.989	1007.380	0.06	3.239	0.09	974.123	0.01	3.738	0.25
A	119a	1007.408	3.345	974.027	2.266								
A	119b	1007.478	3.029	974.071	2.476								
A	119c	1007.344	2.902	973.961	2.573			grain average					
A	119d	1007.345	3.183	973.695	2.771	1007.394	0.06	3.115	0.19	973.939	0.17	2.522	0.21
A	127a	1007.800	3.176	974.369	3.575								
A	127b	1007.848	3.258	974.623	2.570								
A	127c	1007.812	3.100	974.534	2.647			grain average					
A	127d	1007.726	3.130	974.148	2.424	1007.797	0.05	3.166	0.07	974.419	0.21	2.804	0.52
A	71aa	1007.678	3.232	974.294	3.247								
A	71bb	1007.691	3.274	974.231	3.174								
A	71cc	1007.712	3.293	974.321	3.225			grain average					
A	71dd	1007.692	3.284	974.279	3.138	1007.693	0.01	3.271	0.03	974.281	0.04	3.196	0.05

Mt	Grain	V_3SiO_4	hwhm	V_1SiO_4	hwhm	V_3SiO_4	Stdv	hwhm	Stdv	V_1SiO_4	Stdv	hwhm	Stdv
B	21a	1006.869	3.2036	973.8118	3.195								
B	21b	1007.052	3.1622	973.896	3.157								
B	21c	1006.950	3.078	973.814	3.051			grain average					
B	21d	1007.051	3.043	973.858	3.081	1006.981	0.09	3.122	0.07	973.845	0.04	3.121	0.07
B	28a	1006.939	3.337	973.799	3.816								
B	28b	1006.521	3.516	973.593	4.230								
B	28c	1006.225	3.592	973.589	4.244			grain average					
B	28d	1006.938	3.355	973.784	3.708	1006.656	0.35	3.450	0.12	973.691	0.12	4.000	0.28
B	36a	1006.451	3.354	973.548	3.893								
B	36b	1006.373	3.563	973.441	4.002								
B	36c	1006.530	3.462	973.537	3.887			grain average					
B	36d	1006.250	3.443	973.481	4.066	1006.401	0.12	3.456	0.09	973.502	0.05	3.962	0.09
B	37a	1007.551	3.200	974.152	2.940								
B	37b	1007.609	3.023	974.199	2.987								
B	37c	1007.618	3.305	974.253	3.239			grain average					
B	37d	1007.563	2.970	974.195	2.890	1007.585	0.03	3.125	0.16	974.200	0.04	3.014	0.16
B	43a	1007.653	2.982	974.243	2.854								
B	43b	1007.689	2.774	974.282	2.734								
B	43c	1007.558	3.176	974.175	2.919			grain average					
B	43d	1007.651	2.900	974.209	2.477	1007.638	0.06	2.958	0.17	974.227	0.05	2.746	0.19
B	48d	1006.484	3.109	973.500	2.250								
B	48a	1006.921	2.788	973.711	2.410								
B	48b	1007.018	2.998	973.799	2.945			grain average					
B	48c	1006.926	3.032	973.625	3.050	1006.837	0.24	2.982	0.14	973.659	0.13	2.664	0.39
B	77d	1007.404	3.153	974.145	2.785								
B	77a	1007.257	3.291	974.041	3.144								
B	77b	1007.338	3.225	974.154	2.893			grain average					
B	77c	1007.165	3.156	973.961	2.851	1007.291	0.10	3.206	0.07	974.075	0.09	2.918	0.16
B	91a	1007.019	2.870	973.880	3.031								
B	91b	1006.956	2.826	973.735	3.012								
B	91c	1007.198	2.818	973.962	2.916			grain average					
B	91d	1007.211	2.893	974.020	3.065	1007.096	0.13	2.852	0.04	973.899	0.12	3.006	0.06
B	107a	1005.849	2.556	972.868	2.810								
B	107b	1006.140	2.586	973.067	2.971								

B	107c	1006.201	2.639	973.186	2.964			grain average					
B	107d	1005.933	2.459	972.971	2.631	1006.031	0.17	2.560	0.08	973.023	0.14	2.844	0.16
B	122a	1006.430	2.901	973.384	3.999								
B	122b	1006.500	2.331	973.405	2.279								
B	122c	1006.391	2.409	973.281	2.349			grain average					
B	122d	1006.432	2.442	973.294	2.325	1006.438	0.05	2.521	0.26	973.341	0.06	2.738	0.84
B	131a	1007.162	3.182	973.758	3.441								
B	131b	1007.524	1.821	974.115	1.783								
B	131c	1007.114	1.915	973.897	1.911			grain average					
B	131d	1007.539	1.845	974.111	1.781	1007.335	0.23	2.191	0.66	973.970	0.17	2.229	0.81
B	132a	1007.590	2.971	974.201	2.809								
B	132b	1007.577	2.984	974.218	2.823								
B	132c	1007.653	2.986	974.246	2.912			grain average					
B	132d	1007.700	2.930	974.305	2.833	1007.630	0.06	2.968	0.03	974.243	0.05	2.844	0.05
B	149a	1007.450	3.475	974.054	3.253								
B	149b	1007.423	3.527	974.073	3.330								
B	149c	1007.466	3.386	974.133	3.307			grain average					
B	149d	1007.593	3.314	974.253	3.334	1007.483	0.08	3.426	0.09	974.128	0.09	3.306	0.04

Mt	Grain	V_3SiO_4	hwhm	V_1SiO_4	hwhm	V_3SiO_4	Stdv	hwhm	Stdv	V_1SiO_4	Stdv	hwhm	Stdv
C	1a	1007.819	3.341	974.323	3.259								
C	1b	1007.777	3.390	974.287	3.824								
C	1c	1007.364	3.211	974.045	3.060			grain average					
C	1d	1007.717	4.104	974.520	3.672	1007.669	0.21	3.511	0.40	974.294	0.19	3.454	0.35
C	17a	1006.676	3.832	973.553	3.320								
C	17b	1006.714	3.980	973.596	3.634								
C	17c	1006.779	3.921	973.616	3.540			grain average					
C	17d	1006.482	4.055	973.452	3.445	1006.663	0.13	3.947	0.09	973.554	0.07	3.485	0.13
C	18a	1006.737	3.541	973.693	3.370								
C	18b	1006.732	3.845	973.656	3.479								
C	18c	1006.702	3.726	973.615	3.415			grain average					
C	18d	1006.742	3.644	973.656	3.314	1006.728	0.02	3.689	0.13	973.655	0.03	3.394	0.07
C	34a	1006.737	3.541	973.691	3.357								
C	34b	1006.732	3.845	973.659	3.491								
C	34c	1006.702	3.726	973.613	3.402			grain average					
C	34d	1006.742	3.644	973.656	3.314	1006.728	0.02	3.689	0.13	973.655	0.03	3.391	0.08
C	40a	1007.989	2.478	974.563	2.392								
C	40b	1007.986	2.496	974.501	2.360								
C	40c	1008.010	2.477	974.483	2.479			grain average					
C	40d	1007.989	2.498	974.524	2.294	1007.994	0.01	2.487	0.01	974.518	0.03	2.381	0.08
C	56a	1007.801	2.856	974.284	2.497								
C	56b	1007.776	2.841	974.260	2.408								
C	56c	1007.828	2.826	974.274	2.397			grain average					
C	56d	1007.765	2.863	974.233	2.446	1007.793	0.03	2.846	0.02	974.263	0.02	2.437	0.05
C	65a	1006.201	3.745	973.281	3.734								
C	65b	1006.549	3.845	973.475	3.367								
C	65c	1006.505	3.895	973.454	3.656			grain average					
C	65d	1006.455	3.925	973.508	4.260	1006.428	0.16	3.852	0.08	973.429	0.10	3.754	0.37
C	74a	1007.387	3.334	974.032	2.799								
C	74b	1007.391	3.375	973.997	2.953								
C	74c	1007.449	3.506	973.930	3.660			grain average					

C	74d	1007.347	3.432	973.784	2.710	1007.394	0.04	3.412	0.07	973.936	0.11	3.031	0.43
C	77a	1007.588	2.898	974.098	2.332								
C	77b	1007.659	2.992	974.224	3.001								
C	77c	1007.552	3.129	974.335	2.801			grain average					
C	77d	1007.731	3.117	974.689	4.836	1007.633	0.08	3.034	0.11	974.336	0.25	3.243	1.10
C	104a	1007.070	3.218	973.896	3.268								
C	104b	1007.103	3.174	973.810	3.506								
C	104c	1006.981	3.329	973.845	3.391			grain average					
C	104d	1007.106	3.264	973.884	3.301	1007.065	0.06	3.247	0.07	973.859	0.04	3.366	0.11
C	117a	1007.619	3.012	974.384	2.897								
C	117b	1007.578	3.054	974.250	2.792								
C	117c	1007.633	3.010	974.326	2.778			grain average					
C	117d	1007.582	3.005	974.306	2.857	1007.603	0.03	3.020	0.02	974.317	0.06	2.831	0.06
C	135a	1006.839	3.585	973.550	3.167								
C	135b	1006.830	3.404	973.657	3.338								
C	135c	1006.689	3.535	973.735	3.881			grain average					
C	135d	1006.616	3.648	973.481	4.431	1006.744	0.11	3.543	0.10	973.606	0.11	3.704	0.57
C	141a	1007.358	3.371	973.996	2.993								
C	141b	1007.220	3.563	973.874	3.095								
C	141c	1007.191	3.612	973.875	3.652			grain average					
C	141d	1007.238	3.564	973.833	3.139	1007.252	0.07	3.527	0.11	973.894	0.07	3.220	0.29
C	149a	1007.004	4.138	973.525	3.461								
C	149b	1007.217	4.246	973.920	2.623								
C	149c	1007.266	3.797	973.849	3.889			grain average					
C	149d	1007.176	4.179	973.619	5.578	1007.166	0.11	4.090	0.20	973.728	0.19	3.888	1.24
C	162a	1007.428	2.827	974.130	2.739								
C	162b	1007.459	2.914	974.151	3.082								
C	162c	1007.377	2.949	974.184	2.741			grain average					
C	162d	1007.351	2.980	974.124	2.791	1007.404	0.05	2.918	0.07	974.147	0.03	2.838	0.16

Summary Table of Raman Spectroscopy - TI10-7 (Orca Group)

Mt	Grain	V_3SiO_4	St Dev	FWHM	St Dev	V_1SiO_4	St Dev	FWHM	St Dev	n
A	18	1007.560	0.110	6.880	0.261	974.233	0.125	7.676	0.607	4
A	60	1007.799	0.021	6.165	0.076	974.335	0.017	6.401	0.043	4
A	61	1007.258	0.100	6.813	0.429	974.077	0.251	7.036	0.191	4
A	64	1007.868	0.127	6.296	0.497	974.602	0.303	6.082	0.880	4
A	69	1007.216	0.105	6.459	0.181	973.794	0.158	5.140	0.186	4
A	70	1007.554	0.056	5.859	0.082	974.166	0.162	6.198	0.390	4
A	72	1007.354	0.055	6.257	0.043	973.929	0.086	5.224	0.108	4
A	73	1007.403	0.048	5.987	0.088	974.348	0.481	5.482	0.039	4
A	76	1007.797	0.021	5.632	0.036	974.329	0.027	4.989	0.034	4
A	79	1007.569	0.006	6.015	0.038	974.149	0.129	5.220	0.029	4
A	102	1007.293	0.089	6.771	0.119	974.006	0.130	6.997	0.936	4
A	106	1007.380	0.061	6.479	0.086	974.123	0.008	7.477	0.249	4
A	119	1007.394	0.064	6.230	0.192	973.939	0.169	5.043	0.210	4
A	127	1007.797	0.051	6.332	0.069	974.419	0.209	5.608	0.522	4
A	71	1007.693	0.014	6.542	0.027	974.281	0.038	6.392	0.049	4
B	21	1006.981	0.088	6.243	0.074	973.845	0.040	6.243	0.067	4
B	28	1006.656	0.348	6.900	0.124	973.691	0.116	7.999	0.278	4
B	36	1006.401	0.119	6.911	0.086	973.502	0.050	7.924	0.087	4
B	37	1007.585	0.033	6.249	0.156	974.200	0.041	6.028	0.155	4
B	43	1007.638	0.056	5.917	0.169	974.227	0.046	5.493	0.195	4
B	48	1006.837	0.240	5.963	0.137	973.659	0.127	5.328	0.393	4
B	77	1007.291	0.103	6.413	0.066	974.075	0.092	5.836	0.157	4
B	91	1007.096	0.128	5.704	0.036	973.899	0.124	6.012	0.064	4
B	107	1006.031	0.167	5.120	0.076	973.023	0.136	5.688	0.160	4
B	122	1006.438	0.045	5.041	0.258	973.341	0.063	5.476	0.841	4
B	131	1007.335	0.228	4.381	0.662	973.970	0.174	4.458	0.810	4
B	132	1007.630	0.057	5.935	0.026	974.243	0.046	5.689	0.047	4
B	149	1007.483	0.075	6.851	0.094	974.128	0.090	6.612	0.037	4
C	1	1007.669	0.208	7.023	0.402	974.294	0.195	6.907	0.355	4
C	17	1006.663	0.128	7.894	0.094	973.554	0.073	6.969	0.134	4
C	18	1006.728	0.018	7.378	0.129	973.655	0.032	6.789	0.070	4
C	34	1006.728	0.018	7.378	0.129	973.655	0.032	6.782	0.076	4
C	40	1007.994	0.011	4.975	0.011	974.518	0.035	4.762	0.077	4
C	56	1007.793	0.028	5.692	0.016	974.263	0.022	4.874	0.045	4
C	65	1006.428	0.156	7.705	0.079	973.429	0.101	7.509	0.372	4
C	74	1007.394	0.042	6.823	0.074	973.936	0.110	6.061	0.431	4
C	77	1007.633	0.079	6.068	0.109	974.336	0.254	6.485	1.098	4
C	104	1007.065	0.058	6.493	0.066	973.859	0.039	6.732	0.107	4
C	117	1007.603	0.027	6.041	0.023	974.317	0.055	5.662	0.056	4
C	135	1006.744	0.109	7.086	0.103	973.606	0.113	7.409	0.572	4
C	141	1007.252	0.073	7.055	0.107	973.894	0.071	6.440	0.294	4
C	149	1007.166	0.114	8.180	0.200	973.728	0.187	7.775	1.243	4
C	162	1007.404	0.049	5.835	0.066	974.147	0.027	5.677	0.164	4
			0.087		0.135		0.111		0.299	

APPENDIX F:
Figure Length Data

TI10-07 Mean Maximum Figure Length (five largest) (in um)

Grain	Min	Max	Sum	n	Mean	Med.	RMS	St.Dev	Var.	se
A18	0.851	1.240	4.911	5	0.982	0.897	0.993	0.165	27.379	0.074
A60	0.866	1.174	4.821	5	0.964	0.919	0.970	0.121	14.762	0.054
A61	0.849	1.512	5.715	5	1.143	1.003	1.173	0.293	85.755	0.131
A64	1.025	1.587	6.658	5	1.332	1.283	1.347	0.227	51.424	0.101
A69	0.739	1.022	4.330	5	0.866	0.869	0.873	0.125	15.545	0.056
A70	1.083	1.294	5.668	5	1.134	1.092	1.136	0.090	8.166	0.040
A71	0.610	0.761	3.396	5	0.679	0.674	0.681	0.056	3.140	0.025
A72	1.061	1.160	5.520	5	1.104	1.109	1.105	0.037	1.391	0.017
A73	0.798	0.880	4.148	5	0.830	0.799	0.830	0.043	1.830	0.019
A76	0.479	0.709	2.717	5	0.543	0.517	0.550	0.094	8.930	0.042
A79	0.606	0.758	3.421	5	0.684	0.691	0.686	0.059	3.506	0.026
A102	1.012	1.284	5.631	5	1.126	1.071	1.131	0.113	12.809	0.051
A106	0.979	1.374	5.443	5	1.089	1.022	1.098	0.163	26.449	0.073
A119	1.114	1.349	5.967	5	1.193	1.157	1.196	0.091	8.263	0.041
A127	1.076	1.162	5.564	5	1.113	1.116	1.113	0.038	1.411	0.017
B21	0.556	0.871	3.273	5	0.655	0.579	0.665	0.132	17.341	0.059
B28	0.799	0.933	4.332	5	0.866	0.859	0.868	0.053	2.830	0.024
B36	1.209	1.430	6.483	5	1.297	1.259	1.299	0.090	8.052	0.040
B37	0.548	0.791	3.282	5	0.656	0.669	0.663	0.105	11.057	0.047
B43	0.803	0.953	4.301	5	0.860	0.838	0.862	0.058	3.385	0.026
B48	1.389	1.456	7.137	5	1.427	1.433	1.428	0.025	0.632	0.011
B77	0.655	0.877	3.631	5	0.726	0.672	0.731	0.094	8.877	0.042
B82	0.479	0.593	2.677	5	0.535	0.517	0.537	0.046	2.149	0.021
B91	1.151	1.287	6.044	5	1.209	1.206	1.210	0.050	2.461	0.022
B107	1.232	1.444	6.736	5	1.347	1.340	1.350	0.095	9.057	0.043
B122	1.408	1.791	7.588	5	1.518	1.445	1.524	0.160	25.616	0.072
B127	0.642	0.840	3.477	5	0.695	0.671	0.699	0.083	6.815	0.037
B131	0.827	1.010	4.516	5	0.903	0.892	0.905	0.071	5.001	0.032
B132	0.838	1.078	4.738	5	0.948	0.969	0.951	0.093	8.672	0.042
B149	0.770	0.967	4.231	5	0.846	0.835	0.849	0.077	5.979	0.035
C1	1.146	1.470	6.123	5	1.225	1.172	1.231	0.138	18.962	0.062
C17*	1.077	1.395	5.855	5	1.171	1.144	1.177	0.130	16.804	0.058
C18	1.209	1.484	6.338	5	1.268	1.212	1.272	0.121	14.680	0.054
C34	1.213	1.684	6.886	5	1.377	1.236	1.391	0.214	45.845	0.096
C40	0.661	1.123	4.359	5	0.872	0.896	0.885	0.173	29.878	0.077
C56	0.712	1.049	4.092	5	0.818	0.780	0.827	0.135	18.194	0.060
C65	0.896	1.092	4.936	5	0.987	0.999	0.989	0.073	5.267	0.032
C74	0.275	1.402	8.020	9	0.891	1.304	1.028	0.543	294.608	0.181
C77	0.783	1.049	4.288	5	0.858	0.798	0.864	0.114	12.888	0.051
C104	0.839	1.013	4.613	5	0.923	0.936	0.925	0.068	4.609	0.030
C117	0.655	0.812	3.571	5	0.714	0.702	0.716	0.058	3.357	0.026
C135	1.162	1.410	6.350	5	1.270	1.234	1.273	0.102	10.488	0.046
C141	1.102	1.209	5.814	5	1.163	1.163	1.163	0.040	1.579	0.018
C149	0.906	1.140	4.957	5	0.991	0.976	0.995	0.093	8.610	0.041
C162	0.875	1.145	4.740	5	0.948	0.915	0.953	0.113	12.670	0.050

TI10-07 Mean Figure Length (all) (in um)

Grain	Min	Max	Sum	n	Mean	Med.	RMS	St.Dev	Var.	se
A18	0.316	1.240	16.682	22	0.758	0.771	0.780	0.188	35.290	0.040
A60	0.397	1.174	16.287	23	0.708	0.694	0.730	0.180	32.569	0.038
A61	0.315	1.512	24.593	40	0.615	0.536	0.660	0.242	58.721	0.038
A64	0.480	1.587	29.191	38	0.768	0.696	0.810	0.262	68.538	0.042
A69	0.256	1.022	18.314	28	0.654	0.641	0.669	0.145	21.145	0.027
A70	0.360	1.294	44.450	57	0.780	0.769	0.801	0.186	34.589	0.025
A71	0.305	0.761	20.304	40	0.508	0.503	0.517	0.097	9.367	0.015
A72	0.477	1.160	33.370	41	0.814	0.788	0.831	0.171	29.343	0.027
A73	0.420	0.880	18.351	28	0.655	0.668	0.666	0.118	13.840	0.022
A76	0.183	0.709	15.193	42	0.362	0.336	0.377	0.107	11.470	0.017
A79	0.323	0.758	23.273	48	0.485	0.473	0.494	0.098	9.524	0.014
A102	0.351	1.284	41.939	59	0.711	0.652	0.742	0.215	46.020	0.028
A106	0.609	1.374	32.999	40	0.825	0.804	0.837	0.145	20.925	0.023
A119	0.454	1.349	46.469	52	0.894	0.915	0.910	0.176	31.002	0.024
A127	0.392	1.162	74.832	100	0.748	0.726	0.770	0.181	32.627	0.018
B21	0.289	0.871	21.747	49	0.444	0.423	0.457	0.110	12.003	0.016
B28	0.340	0.933	53.358	92	0.580	0.568	0.591	0.116	13.358	0.012
B36	0.604	1.430	72.518	73	0.993	1.016	1.006	0.160	25.644	0.019
B37	0.350	0.791	9.350	19	0.492	0.454	0.505	0.118	13.953	0.027
B43	0.305	0.953	22.786	36	0.633	0.616	0.648	0.141	19.828	0.023
B48	0.426	1.456	45.310	55	0.824	0.735	0.865	0.265	70.183	0.036
B77	0.433	0.877	19.226	33	0.583	0.581	0.589	0.087	7.529	0.015
B82	0.283	0.593	6.201	14	0.443	0.458	0.452	0.093	8.578	0.025
B91	0.296	1.287	33.959	47	0.723	0.654	0.772	0.274	74.883	0.040
B107	0.779	1.444	73.960	71	1.042	1.010	1.050	0.131	17.127	0.016
B122	0.646	1.791	47.661	40	1.192	1.170	1.208	0.202	40.706	0.032
B127	0.359	0.840	18.837	33	0.571	0.574	0.577	0.084	7.015	0.015
B131	0.512	1.010	21.691	31	0.700	0.678	0.709	0.117	13.753	0.021
B132	0.330	1.078	23.144	38	0.609	0.571	0.634	0.178	31.839	0.029
B149	0.396	0.967	20.911	33	0.634	0.665	0.649	0.140	19.724	0.024
C1	0.436	1.470	43.594	58	0.752	0.693	0.783	0.221	48.628	0.029
C17*	0.427	1.395	48.355	65	0.744	0.714	0.770	0.200	40.085	0.025
C18	0.314	1.484	33.048	40	0.826	0.811	0.878	0.300	89.810	0.047
C34	0.465	1.684	33.042	35	0.944	0.885	0.975	0.249	61.879	0.042
C40	0.246	1.123	11.380	22	0.517	0.469	0.565	0.234	54.677	0.050
C56	0.293	1.049	34.501	67	0.515	0.510	0.531	0.129	16.729	0.016
C65	0.275	1.092	41.500	64	0.648	0.625	0.667	0.160	25.480	0.020
C74	0.275	1.402	87.905	115	0.764	0.730	0.801	0.240	57.514	0.022
C77	0.177	1.049	25.448	41	0.621	0.625	0.638	0.147	21.745	0.023
C104	0.329	1.013	27.382	46	0.595	0.534	0.620	0.175	30.679	0.026
C117	0.447	0.812	11.932	20	0.597	0.570	0.603	0.092	8.471	0.021
C135	0.564	1.410	53.958	54	0.999	0.983	1.008	0.134	17.983	0.018
C141	0.370	1.209	46.156	57	0.810	0.800	0.828	0.173	30.073	0.023
C149	0.301	1.140	30.292	49	0.618	0.604	0.646	0.190	36.018	0.027
C162	0.314	1.145	30.333	45	0.674	0.662	0.692	0.158	25.008	0.024