

Thermochronological records of tectonics along the northwestern North American margin: Vancouver Island, Canada

by

QIAO Xin

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We acknowledge and respect the Lək'wəḡən (Songhees and X^wsepsəm/ Esquimalt)
Peoples on whose territory the university stands, and the Lək'wəḡən and W̱SÁNEĆ
Peoples whose historical relationships with the land continue to this day.

Supervisory Committee

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ABSTRACT

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How the oceanic plates west of North America evolved and shaped the continental margins remains a subject of active debate. The Eocene ridge-trench interactions between the Kula/Resurrection-Farallon ridge and the western North American margin initiated a complex tectonic regime involving plate fragmentation, ridge subduction and oceanic plateau accretion, the details of which remain debated. The Cenozoic history of Vancouver Island records the long-term response of the crust to changes in this plate configuration of the convergent margin. This thesis employs multiple low-temperature thermochronometers to reconstruct the thermal and exhumation history of crust that underlies Vancouver Island. The objective is to resolve the spatial and temporal variations in the cooling patterns to provide new insights into the paleo-plate configurations and convergence processes that have shaped the northwestern North American margin throughout the Cenozoic.

Across the southern Wrangellia terrane of Vancouver Island, apatite fission track (AFT) ages of 85–23 Ma and apatite (U-Th)/He (AHe) ages of 37–14 Ma reveal variable cooling patterns since the late Cretaceous. Thermal history modeling indicates accelerated Eocene cooling (4–5 °C/Myr) adjacent to major thrust faults, interpreted as a response to oroclinal bending following plateau accretion. In contrast, the west coast experienced minimal cooling (<0.5 °C/Myr) until ~30 Ma, followed by a moderate phase (1.5–3 °C/Myr) linked to the establishment of the Cascadia subduction zone. These patterns suggest the presence of a widespread Eocene sedimentary cover, and the Leech River Complex of the Pacific Rim terrane being partly the outboard equivalent of this cover.

Along the strike of Vancouver Island, AHe, AFT and zircon (U-Th-Sm)/He (ZHe) ages and inverse thermal models show a stark contrast from north to south. The northernmost region experienced prolonged thermal quiescence before 40 Ma followed by slow exhumation, with ZHe, AFT and AHe ages of 147–101, 138–95 and 45–12 Ma, respectively. In contrast, the central-southern island records more rapid exhumation that decelerated after ~50 Ma, with ZHe, AFT and AHe ages of 83–31, 61–17 and 45–12 Ma, respectively. These differing exhumation patterns are explicable if Cascadia subduction established earlier over central-southern Vancouver Island (~50 Ma) than in the northernmost region (~40 Ma), reflecting a northward migration of the Juan de Fuca plate boundary during the early stages of Cascadia subduction. This northern boundary was juxtaposed to the north with the translational motion of the Kula/Resurrection plate. Then the Kula/Resurrection-Juan de Fuca ridge shifted

northward ~ 40 Ma following either complete subduction of Resurrection plate beneath southern Alaska or the merging of the Pacific and Kula plates. This reorganization led to the establishment of a uniform slow exhumation across Vancouver Island thereafter. The northern extent of the Eocene Cascadia margin can thus be constrained to have started off northern-central Vancouver Island.

Finally, thermal history reconstruction of Vancouver Island at temperatures over $250\text{ }^{\circ}\text{C}$ was also investigated using the novel approach of dating radiation damage in zircon using Raman spectroscopy. With its thermal sensitivity, age calculation method, and evaluation protocol established, zircon Raman dating has emerged as a new approach to low-temperature thermochronology within the $260\text{--}370\text{ }^{\circ}\text{C}$ closure interval. Intrusive samples with distinct and well-constrained thermal histories from Vancouver Island, including rapid cooling, multi-stage cooling, and prolonged residence at $2\text{--}4$ km depth, are analyzed to evaluate the technique's applicability as a thermochronometer in subduction margin settings. Five samples yield zircon Raman ages consistent with previously constructed thermal history models, whereas three samples show anomalously old outliers. The different Raman bands show different sensitivities to thermal disturbances, necessitating band-specific interpretations of the resulting ages. The results validate the application of zircon Raman dating for reconstructing various cooling paths and suggest that further methodological improvements should focus on low-damage samples, long-term thermal histories, and integration with other thermochronometers.

Collectively, this work provides a comprehensive thermochronological framework for Vancouver Island, providing views of how the island's crust responded to the plate

boundary evolution along northwestern North America through the Cenozoic. The results reveal a coherent exhumation pattern associated with the Eocene ridge-trench interactions and transition from Farallon to Cascadia subduction. This work also demonstrates the value of zircon Raman dating in resolving thermal histories in active plate convergence settings.

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Chapter 1

Introduction

1.1 Overview and Goals

The tectonic evolution of a convergent setting is a dynamic process that shapes the landscape and can create complex geology at the continental margins. The continuous convergence between tectonic plates provides the fundamental force that builds topography by crustal shortening, buries rocks along the subduction zone, and often promotes exhumation of rocks towards the surface. Exhumation refers to a process by which rocks once buried at depth are uplifted and exposed on the Earth's surface (England and Molnar, 1990; Ring et al., 1999; Reiners and Brandon, 2006). This process is typically a combined consequence of tectonic uplift and surface erosion which together control how quickly rocks reach the surface and how topography evolves over time (England and Molnar, 1990; Ring et al., 1999; Burbank, 2002; Konstantinovskaia and Malavieille, 2005; Malusà and Fitzgerald, 2018). Ultimately, the morphology of convergent margins is sculpted by the competition between tectonic processes that build relief and erosional processes that reduce it.

Along the oceanic-continental convergent boundary of the western North American plate, the exhumation is primarily controlled by subduction and accretion across the trench. The plate configurations along the margin hypothesized for the last 100 Myr are shown in Figure 1.1. The margin is composed of accreted terranes (Monger et al., 1982). The precise paleo-geographic trajectories and accretion ages of individual terranes remain debated, but it is generally accepted that they had traveled over long distances prior to accretion to the western margin of North America (Cowan et al., 1997; Enkin et al., 2006; Miller et al., 2006; Wang et al., 2023). During the early

Cenozoic, the Wrangellia terrane, which is part of the westernmost part of the Insular superterrane and forms much of Vancouver Island, formed the upper plate above the subducting Kula/Resurrection and Farallon plates. Around 50 Ma, a fundamental change in the plate arrangements occurred, marked by oceanic plateau accretion, near-trench magmatism, and slab window formation (Madsen et al., 2006; Wells et al., 2014; Clennett et al., 2020; Fuston and Wu, 2021). These processes may have caused uplift and exhumation of Wrangellia along the margin.

Vancouver Island occupied a key position along the Wrangellia margin, along the leading edge of the active trench near a ridge–trench intersection for at least 100 Myr (Figure 1.2). Several hypotheses have been proposed to address crustal deformation and exhumation of the Wrangellia terrane. Johnston and Acton (2003) documented the crustal shortening pattern and an oroclinal bending of southern Vancouver Island based on structural orientation and paleomagnetic data, interpreted to result from terrane accretion to the margin in the Eocene. Similarly, Finley et al. (2019) interpreted crustal deformation in response to accretion and bending around the Olympic Mountains based on the present-day strain field inferred from Global Navigation Satellite System (GNSS) velocity data. A second hypothesis (Schoettler-Greene et al., 2020) is proposed about Wrangellia uplift around Haida Gwaii since ~ 18 Ma by the compressive motion between an oceanic plateau and the North American margin. Finally, based on the chronology of forearc magmatic belts, Madsen et al. (2006) proposed that localized thermal events associated with slab window formation and near-trench magmatism during ridge subduction outboard of Wrangellia may have facilitated exhumation of the overriding plate.

Many questions remain concerning the evolving tectonic mechanisms responsible for exhumation of the upper crust at the northwestern North American margins. The central aim of this thesis is to reconstruct spatial and temporal variations in exhumation.

tion of Vancouver Island through integrated application of multiple low-temperature thermochronological techniques. The results can offer new insights into the tectonic evolution at the plate boundary that have shaped the continental margins. In pursuit of this objective, my work addresses the following key questions:

What are the thermal and exhumation histories of Vancouver Island? Vancouver Island is positioned at the leading edge of the North American plate. However, a systematic thermochronological dataset of its exhumation history is lacking compared to the dataset for the surrounding continental margins.

How did the Eocene plate reorganization influence uplift and exhumation of Vancouver Island? As mentioned above, major plate reorganization occurred offshore of western North America during the Eocene, and likely modified the crustal deformation and exhumation of the overriding plate. Establishing such thermochronological dataset will allow for a complete reconstruction of how this segment of the overriding plate has responded to the long-term evolution of the plate boundary and will help resolve the ongoing debate over the timing and extent of the initiation of the Eocene Cascadia margin.

Can a novel zircon Raman dating approach help clarify rock exhumation extending to over 250 °C? This recently established technique provides an efficient and cost-effective dating method that complements systems such as fission track and (U-Th)/He thermochronology. With relatively simple but spatially variable thermal histories, Vancouver Island provides an ideal natural laboratory for testing the applicability of this new tool to constrain exhumation processes in a subduction margin setting.

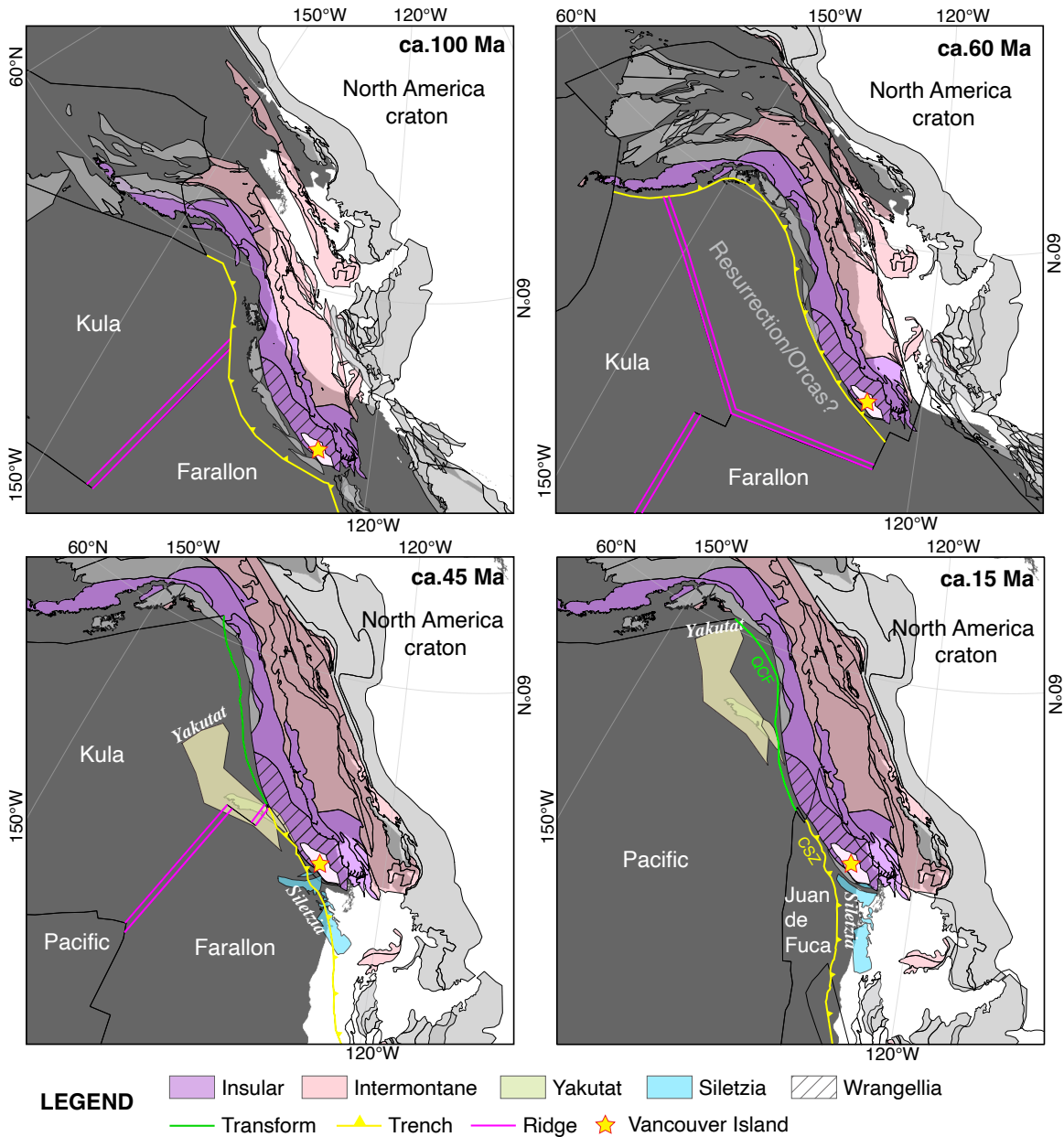


Figure 1.1: Tectonic evolution of northwestern margin of North America surrounding Vancouver Island. Schematic plate configuration at 100, 60, 45, and 15 Ma in a fixed reference frame of North America craton (white place) using GPlates (Müller et al., 2019; Clennett et al., 2020; Alfonso et al., 2025). Thin black lines show boundaries of terranes. Note that Kula plate was captured by the Pacific plate by ~40 Ma and started moving with it. Location of Vancouver Island is shown in light purple and labeled as VI in all sub-plots. Yakutat and Siletzia terranes likely straddled the Kula/Resurrection-Farallon ridge and then split. The line patterns show the estimated location of the Wrangellia terrane. QCF: Queen Charlotte Fault, CSZ: Cascadian Subduction Zone.

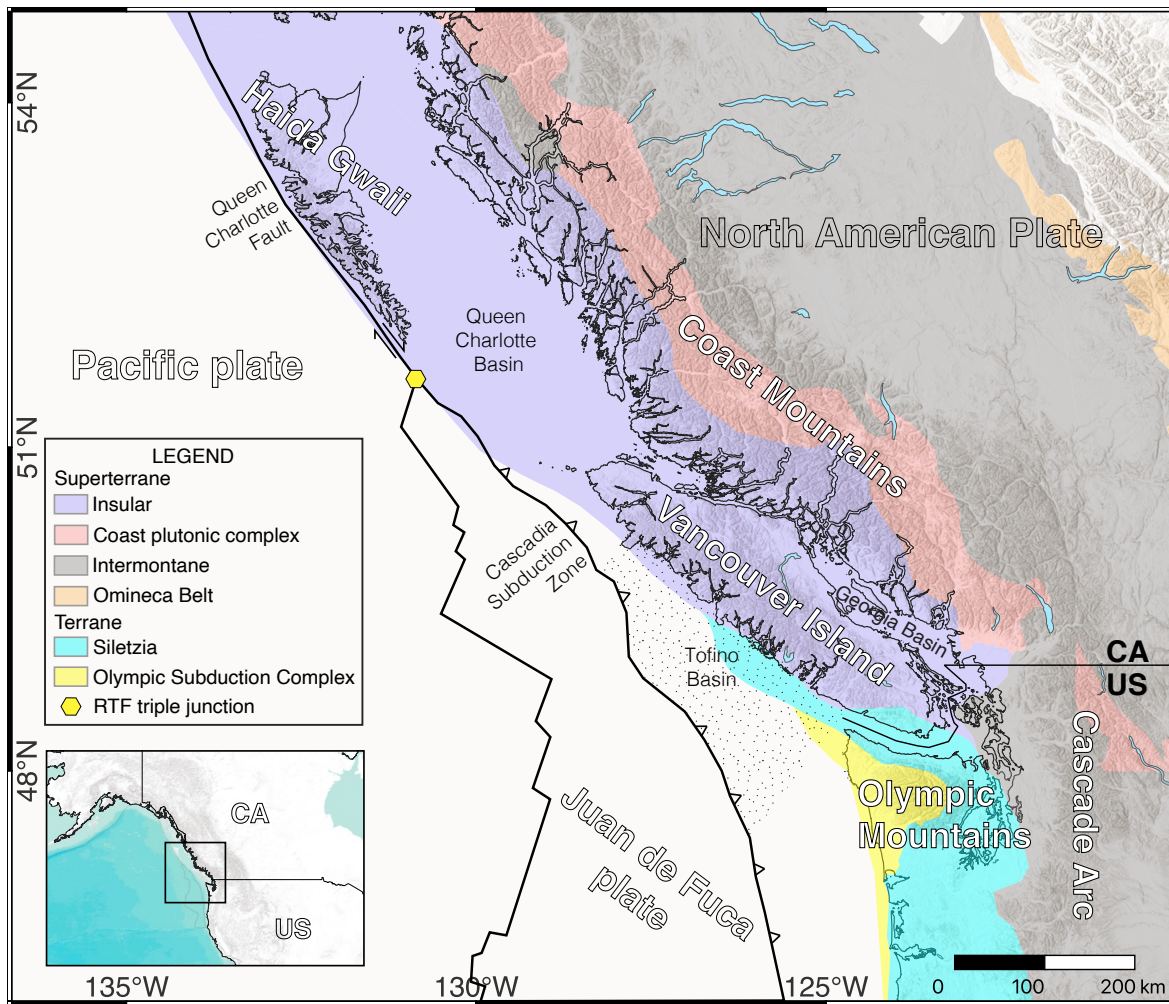


Figure 1.2: Geology map of northwestern margin of North America surrounding Vancouver Island. Terrane boundaries based on maps of Wheeler et al. (1991) and Huntting et al. (1961). The black lines and the hexagonal symbols depict the plate boundaries and the RTF (ridge-trench-fault) triple junction between Pacific, North America and Juan de Fuca plates, respectively. The sand pattern marks the location of Tofino Basin. Main surrounding regions are labeled in white. The inset shows the location of the study region in the world.

1.2 Concept of Exhumation

The Earth’s lithosphere is in a constant state of flux, either thermally or tectonically. Thermally, heat flows from the Earth’s hotter interior towards the cooler surface, causing increasing temperature with depth termed the geothermal gradient (Pollack et al., 1993; Reiners and Brandon, 2006; Jaupart and Mareschal, 2010). Circulation of heat is closely related to circulation of mass. Tectonically, lateral plate motions drive vertical motions of rocks from deep within the crust to the surface.

Three types of vertical displacement in the direction opposite to gravity, and relative to different reference frames were defined by England and Molnar (1990). Rock uplift refers to the displacement of rocks relative to the geoid, such as the mean sea level. Surface uplift is defined as the vertical movement of the Earth’s surface—specifically, the interface between rock and air—also relative to the geoid. Exhumation refers to the unroofing history of rocks towards the Earth’s surface, as a result of the removal of the crustal mass by tectonic or erosional denudation (England and Molnar, 1990; Ring et al., 1999; Reiners and Brandon, 2006). Erosional denudation operates through weathering and erosion from the surface, whereas tectonic denudation is driven by crustal deformation processes such as crustal shortening and faulting. The relation between the three quantities was given by England and Molnar (1990) (Figure 1.3):

$$\textit{Exhumation} = \textit{Rock uplift} - \textit{Surface uplift} \quad (1.1)$$

As a rock ascends through the crust during exhumation, it undergoes cooling as it crosses progressively cooler isotherms. This cooling history is recorded in the temperature-sensitive isotopic systems of mineral grains that make up these rocks, providing a window into the timing and rates of tectonic and erosional processes. In orogenic settings, cooling rate records the temperature change during the period of exhumation, while

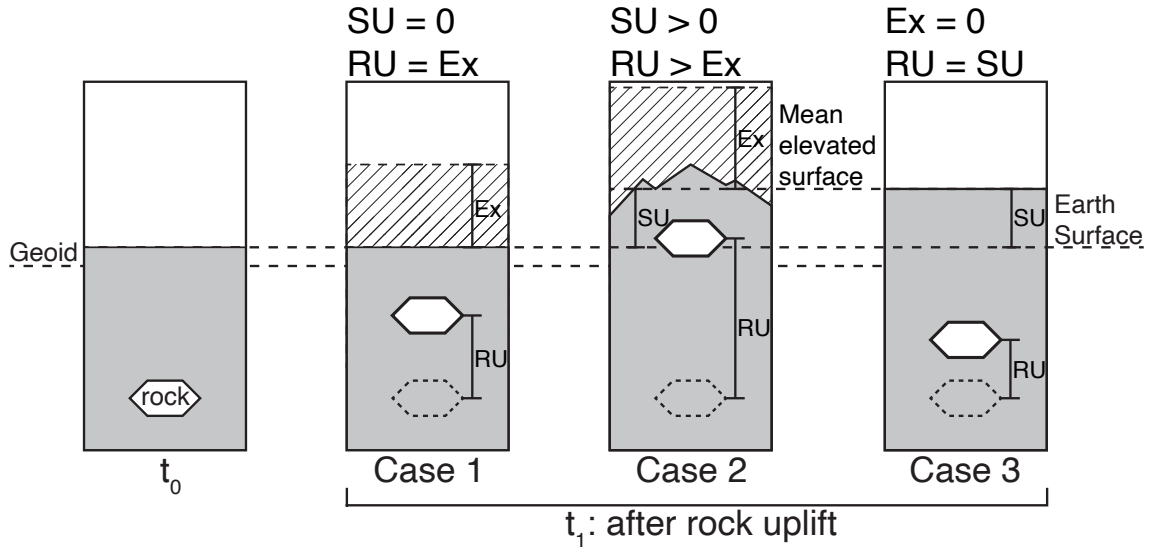


Figure 1.3: Possible relationships between exhumation, rock uplift and surface uplift in three key scenarios: stable topography, mountain building, and the absence of exhumation. Plot adapted from Malusà and Fitzgerald (2018). RU: Rock Uplift, SU: Surface Uplift, Ex: Exhumation.

an exhumation rate records change in elevation with the assumption of an ambient geothermal gradient (England and Molnar, 1990; Braun, 2002; Reiners and Brandon, 2006). The term of exhumation rate also differs from erosion rate, which is the removal rate of material from the surface that can be measured using the burial dating method of cosmogenic nuclides such as ^{10}Be , ^{26}Al in the sediment load in rivers (Nishiizumi et al., 1993; Granger et al., 1996). In addition to exhumation, the cooling process can also be influenced by localized thermal disturbances, such as intrusions and frictional heating along faults (Ehlers and Farley, 2003; Reiners et al., 2005; Malusà and Fitzgerald, 2018).

1.3 Fundamentals of Thermochronology

The exhumation rate records rocks moving toward the surface, often measured using thermochronology. Thermochronometric methods use temperature-sensitive isotopic

systems within minerals such as apatite, zircon, and titanite, to record the time of cooling below a specific closure temperature (T_c). The closure temperature represents a start line for the isotopic clock, from which a rock retains its radiogenic daughter product, approximated by the equation of Dodson (1973):

$$T_c = R / [E \ln (A\tau D_0/a^2)] \quad (1.2)$$

where R is the gas constant, E the activation energy for diffusion, A a numerical constant depending on the geometry and decay constant, D_0 the diffusion coefficient at infinitely high temperature, a the dimension of the diffusion domain, τ the time taken for the diffusivity to decrease related to temperature (T) and cooling rate (dT/dt) by:

$$\tau = -RT^2/E(dT/dt). \quad (1.3)$$

The validity of the closure temperature concept is based on several key assumptions: cooling at a constant rate, negligible initial concentration of the daughter product, homogeneous chemical composition and complete retention of the daughter product below T_c (Dodson, 1973; Flowers et al., 2023b).

A thermochronologic age represents the time a rock cooled through its closure temperature. This correlation is illustrated graphically (Figure 1.4) (Dodson, 1973). As temperature decreases during exhumation, the daughter/parent isotope ratio (D/P) begins to accumulate quantitatively since a time that defines its closure temperature (T_c). A principle age equation used in most radiogenic isotope dating methods is given by:

$$D = P(e^{\lambda t} - 1) \quad (1.4)$$

where D and P are the daughter and parent products concentrations, λ the decay

constant and t the thermochronological age. In practice, the transition from open to closed isotopic system occurs over a temperature range, known as a partial annealing zone (PAZ) or partial retention zone (PRZ). Unlike the closure temperature (T_c) which represents a single point of the 50% of daughter product retention, the PRZ or PAZ defines a temperature range of 10% to 90% retention (Figure 1.5), typically the range over which apparent ages change most rapidly (Gleadow and Fitzgerald, 1987; Wolf et al., 1996). The PAZ and PRZ describe the same concept, but differ in the mechanism: the PAZ involves the repair of crystal damage through annealing (e.g., fission tracks), while the PRZ involves the escape of gas atoms by diffusion (e.g., noble gas thermochronometers) (Malusà and Fitzgerald, 2018).

Low-temperature thermochronology refers to a suite of thermochronological techniques used to reconstruct the thermal evolution of rocks below approximately 350°C. Widely used low-temperature thermochronometers include (U-Th-Sm)/He, fission-track (FT), and $^{40}\text{Ar}/^{39}\text{Ar}$ methods. A recent addition to this suite is zircon Raman dating. The tools applied in this thesis and their typical closure temperature ranges (Figure 1.6) include: 30–90 °C for apatite (U-Th-Sm)/He (Zeitler et al., 1987; Farley, 2000; Gautheron et al., 2009), 60–120 °C for apatite fission track (AFT) (Wagner, 1968; Naeser and Faul, 1969), 160–220 °C for zircon (U-Th-Sm)/He (Reiners et al., 2004; Reiners, 2005; Guenthner et al., 2013), and 260–370 °C for zircon Raman dating (Pidgeon, 2014; Ginster et al., 2019; Härtel et al., 2021b). Different thermochronometers with various temperature sensitivities allow researchers to decipher the cooling signatures associated with distinct phases of exhumation and uplift. Understanding these processes is fundamental to reconstructing the thermal and deformational history of mountain belts, rift systems, and other geodynamic settings. By integrating multiple thermochronometric systems, I undertake a systematic investigation of the low-temperature thermal evolution of Vancouver Island, provide constraints on longer-

term temporal and spatial cooling variations and assess the implications for regional tectonics along the northwestern North American margin.

1.3.1 (U-Th-Sm)/He Dating Basics

The (U-Th-Sm)/He method is based on the radioactive alpha-decay process, where stable alpha particles (^4He) are produced and thermally activated by volume diffusion, leading to the following ingrowth equation:

$$[^4\text{He}] = 8[^{238}\text{U}] (e^{\lambda_{238}t} - 1) + 7[^{235}\text{U}] (e^{\lambda_{235}t} - 1) + 6[^{232}\text{Th}] (e^{\lambda_{232}t} - 1) + [^{147}\text{Sm}] (e^{\lambda_{147}t} - 1) \quad (1.5)$$

where t is time, $[^4\text{He}]$, $[^{238}\text{U}]$, $[^{235}\text{U}]$, $[^{232}\text{Th}]$ and $[^{147}\text{Sm}]$ the present-day atom concentrations in the mineral, and λ the decay constants of the respective parent nuclides. During α -decay (Figure 1.7), the generated He nucleus acquires kinetic energy from the parent isotope and is ejected through the crystal lattice in a random direction, a process known as α -ejection. At the same time, the parent isotopes recoil a bit (α -recoil), which produces lattice defects known as radiation damage (Farley, 2002; Ketcham et al., 2011). Radiation damage depends on the effective dose, which accounts for the accumulated damage generated during He production (α -dose) with a correction of annealing (Flowers et al., 2023b). He atoms retained within the grain can randomly access the neighboring sites within the crystal, a process termed He diffusion controlled by parameters including the thermal history, radiation damage, grain size, chemical composition, and geometry (Farley, 2000; Reiners et al., 2002; Shuster et al., 2006; Gautheron et al., 2009; Guenthner et al., 2013). Comprehensive reviews of (U-Th-Sm)/He thermochronology can be found in some previous articles (Farley, 2002; Reiners, 2005; Flowers et al., 2023a,b).

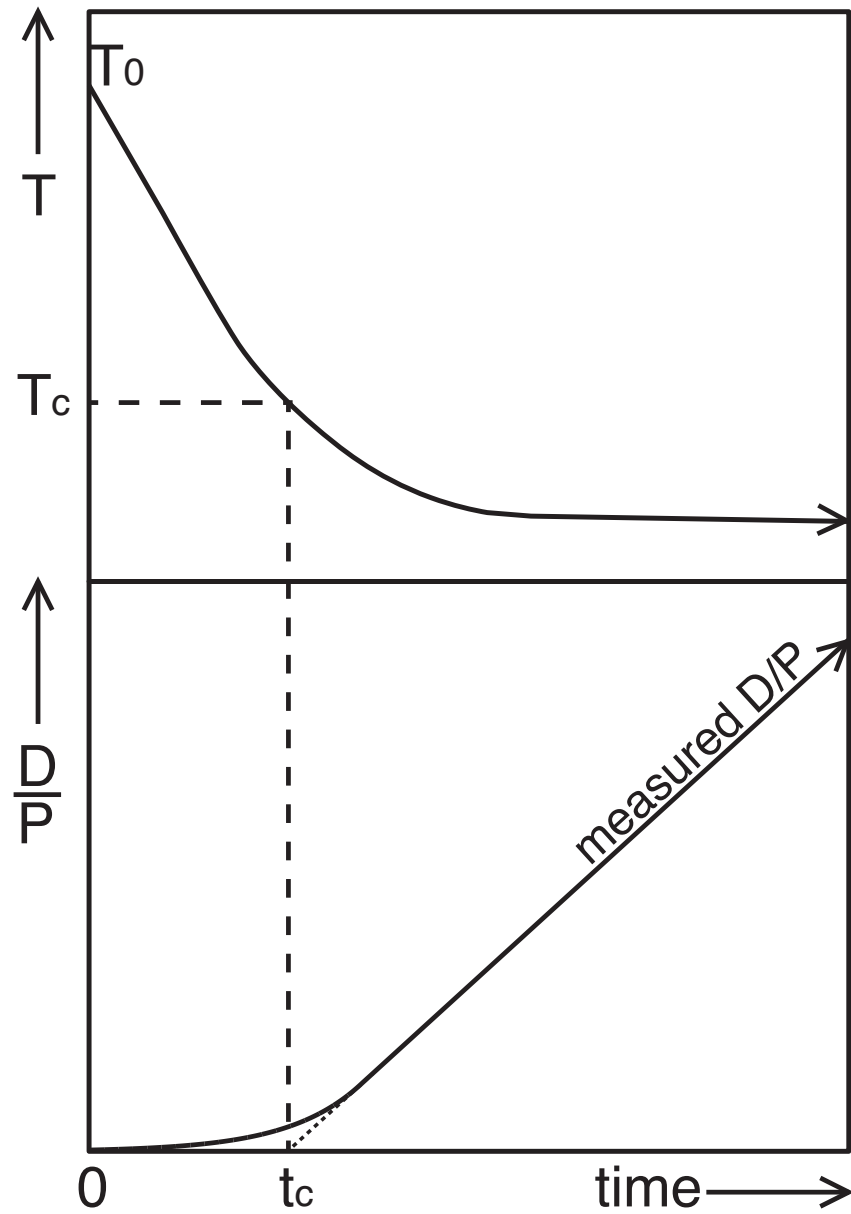


Figure 1.4: The concept of closure temperature (T_c) and its relation to the apparent age (t_c), defined by and modified from Dodson (1973). The upper panel depicts the sample's cooling history, starting from an initial temperature (T_0). The lower panel plots the increase of daughter-parent isotope ratio (D/P) over time. Time t_c corresponds to the time when the sample cooled through the T_c .

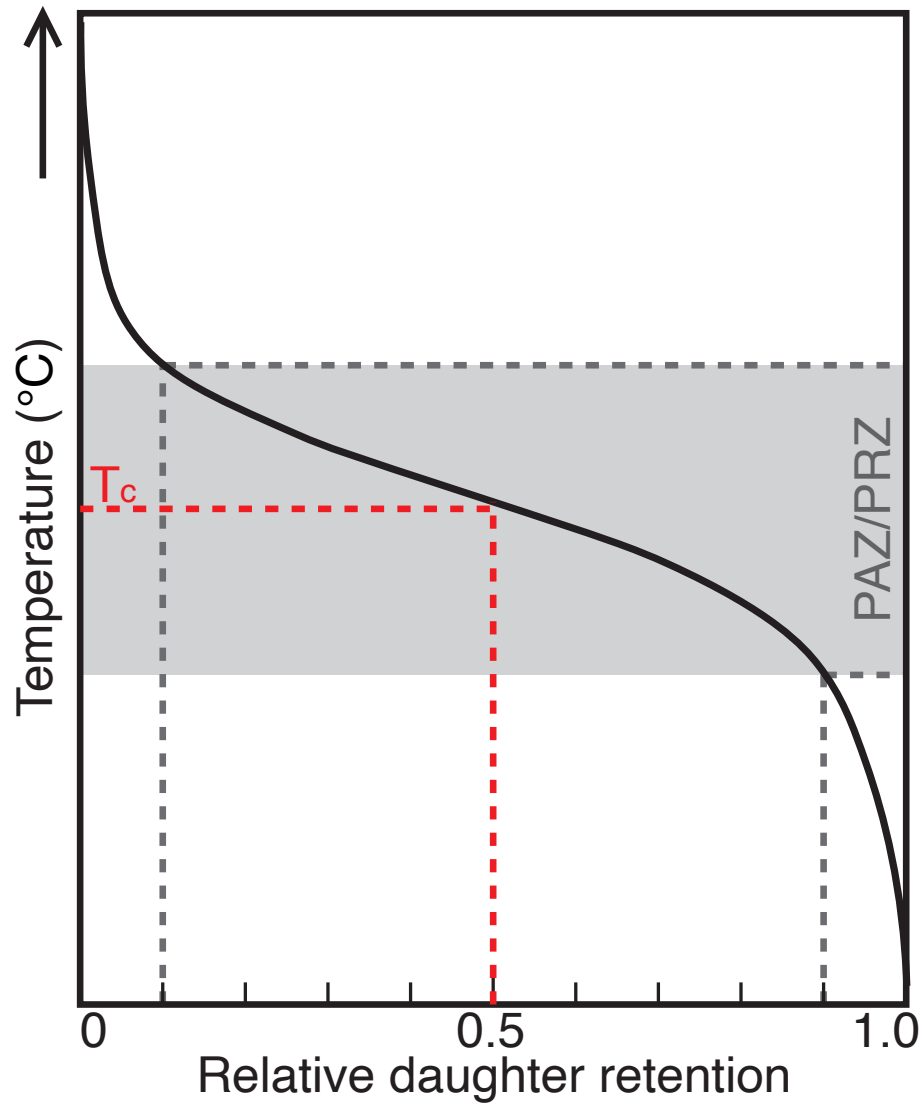


Figure 1.5: The conceptual relationship between closure temperature (T_c) and partial annealing zone (PAZ) or partial retention zone (PRZ), defined by Dodson (1973); Gleadow et al. (1986); Wolf et al. (1996). The plot depicts the decrease of temperature with retention of daughter product.

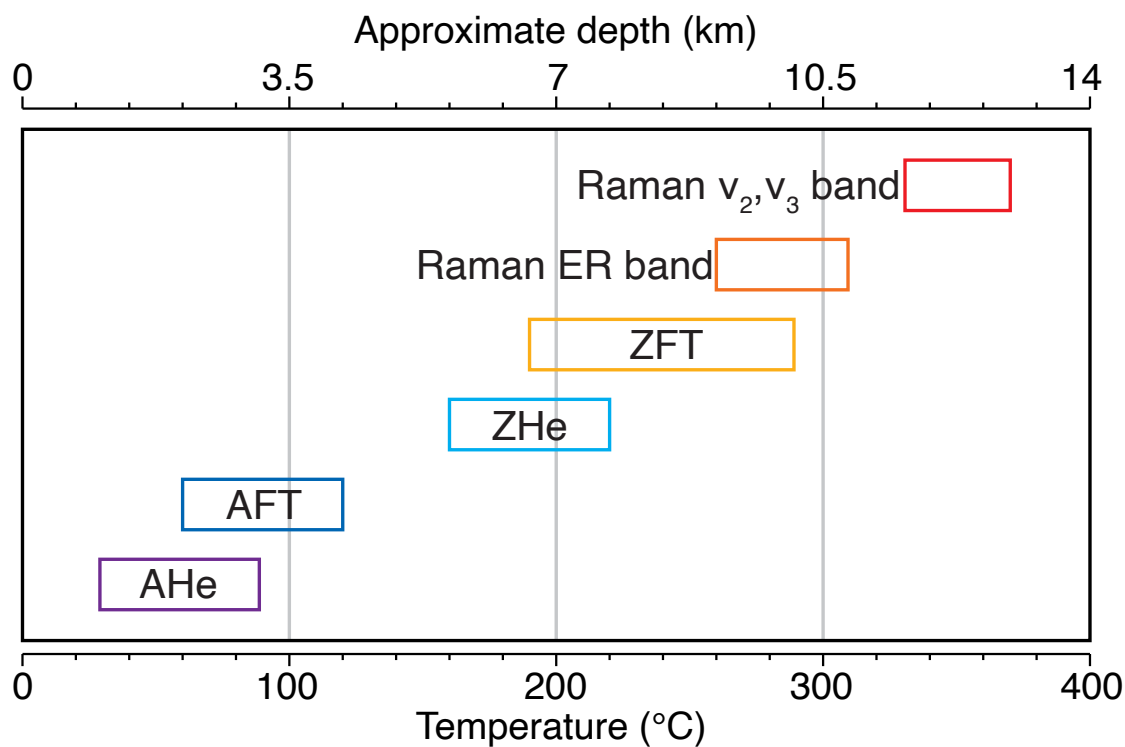


Figure 1.6: Typical closure temperature ranges for common low-temperature thermochronometers, including zircon Raman dating (Pidgeon, 2014; Ginster et al., 2019; Härtel et al., 2021b), zircon fission track (ZFT) (Yamada et al., 1995; Tagami, 2005), zircon U-Th/He (ZHe) (Reiners et al., 2004; Reiners, 2005; Guenthner et al., 2013), apatite fission track (AFT) (Wagner, 1968; Naeser and Faul, 1969), and apatite U-Th/He (AHe) (Zeitler et al., 1987; Farley, 2000; Gautheron et al., 2009). The corresponding depth is estimated assuming an average geothermal gradient of $25\text{--}30\text{ }^{\circ}\text{C}/\text{km}$.

1.3.2 Fission Track Dating Basics

The fission track dating method is based on the analysis of the linear damage trails produced during the spontaneous fission decay of ^{238}U atom, revealed by acid etching (Figure 1.7). During the fission decay, tracks accumulate below the closure temperature when they are no longer annealed, and the measured track density is employed to estimate the time elapsed since accumulation (Wagner, 1968). A nascent fission track has an etched length of about $16\text{ }\mu\text{m}$ in apatite (Gleadow et al., 1986) and $11\text{ }\mu\text{m}$ in zircon (Hasebe et al., 1994). Fission tracks in natural samples are subject to thermally activated annealing as soon as the tracks form, manifested as shortened track length and decreased track density. The degree of fission track annealing largely reflects the sample's thermal history, while factors such as crystallographic orientation, grain composition, and possibly radiation damage also play a role (Donelick, 1991; Donelick et al., 1999; Crowley et al., 1991; Carlson et al., 1999; Rahn et al., 2004). Reviews of the principle and analytical workflow of the method were provided in recent decades (Gallagher et al., 1998; Gleadow et al., 2002; Donelick et al., 2005; Tagami, 2005; Kohn et al., 2024).

1.3.3 Raman Dating Basics

Zircon Raman dating method is based on the quantification of accumulated radiation damage mainly generated by α -ejection and α -recoil during alpha-decay process in zircon (Nasdala et al., 2001). The present-day radiation damage densities are measurable as alpha-doses through Raman spectroscopy (Pidgeon et al., 1998; Nasdala et al., 2001, 2002). The lattice defects can be partially or completely annealed during thermal heating (Nasdala et al., 2001; Härtel et al., 2022b, 2024). Only in recent years has a standardized analytical approach for zircon Raman dating been developed (Pidgeon,

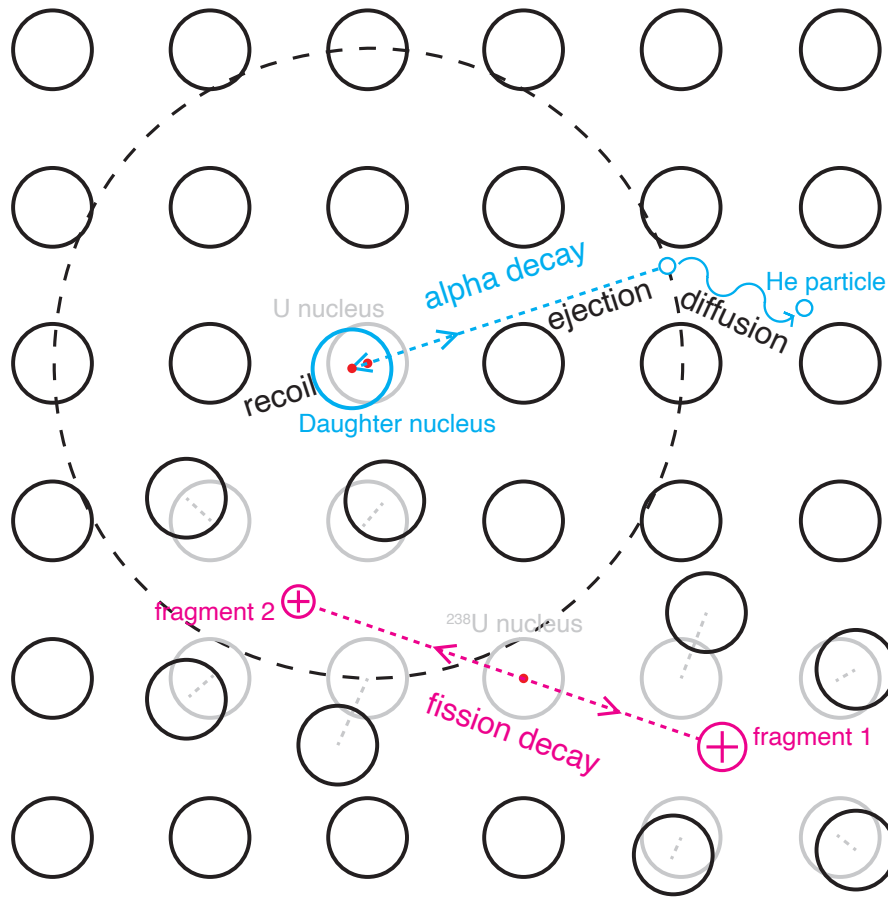


Figure 1.7: Illustration shows lattice defects produced during alpha decay (blue) and fission decay (pink) processes. A dashed circle indicate the stopping distance of alpha-particles (average $18\text{ }\mu\text{m}$) ejected during alpha decay. While these alpha-particles diffuse randomly, the recoiling daughter nucleus also damages the crystal lattice. In contrast, nuclear fission produces two positively charged fragments that are ejected in opposite directions. Their strong Coulomb repulsion displaces nearby atoms electrostatically, creating a linear damage trail (fission track).

2014; Anderson et al., 2020; Härtel et al., 2021a,b, 2022b).

1.3.4 Thermal Modelling Basics

The integration and interpretation of data from multiple thermochronometers can be greatly facilitated by numerical thermal modelling. Raw data, including ages and fission track lengths, are fed into quantitative models to perform data inversion, derive time–temperature paths, and guide sampling within a pre-defined model domains. In this study, inverse modeling is performed using the QTQt software, which employs a transdimensional Bayesian Markov Chain Monte Carlo (MCMC) algorithm. The inversion process begins with a random walk through the model space to generate predictions under a set of kinetic parameters. Model predictions are compared to observed data via a likelihood function, and thermal histories that meet the acceptance criteria are added to the output ensemble. A penalty is incorporated into the likelihood function such that the algorithm tends to favor simpler solutions and limit over-interpretation. Detailed descriptions of the QTQt inverse modeling approach are provided by Gallagher et al. (2009) and Gallagher (2012).

1.4 Previous Thermochronological Studies

Low-temperature thermochronology offers a tool to constrain the uplift and exhumation history of the upper crust, reflecting how tectonic evolution influences the vertical crustal deformation over a million-year time scale. This section reviews previous low-temperature thermochronologic studies from Vancouver Island and adjacent regions, that were used to investigate Mesozoic to late Cenozoic exhumation.

On southern Vancouver Island, a set of AFT (85–23 Ma) and AHe (37–14 Ma) ages were reported in a few studies (Figure 1.8) (Currie and Grist, 1996; England et al., 1997;

Currie and Grist, 2024). The Eocene-Oligocene exhumation inferred from these data was interpreted as records of oroclinal bending of the southern island following Siletzia accretion and subduction initiation of the Juan de Fuca plate. To the north, 3 ZHe, 6 AFT, and 20 AHe ages of 60–5 Ma were reported on Haida Gwaii (Figure 1.8), with inferred accelerated exhumation at 16–18 Ma attributed to the outboard translation of an oceanic plateau (the Yakutat terrane) (Schoettl-Greene et al., 2020). To the east in the Coast Mountains, zircon fission-track (ZFT) ages ranging 100–30 Ma and AFT ages <90 Ma record exhumation of ~ 0.2 mm/yr since ~ 15 Ma (Parrish, 1983; O’Sullivan and Parrish, 1995), consistent with paired uplift of the Coast Mountains and subsidence in the Queen Charlotte basin caused by lithosphere thinning (Rohr and Currie, 1997). In the same region, AHe ages younger than 20 Ma in later studies indicate rapid uplift and erosion of the Coast Mountains at over 0.4 mm/yr after ~ 7 Ma, driven by intense glacial incision (Farley et al., 2001; Ehlers et al., 2006; Densmore, 2008). To the south, in the Olympic Mountains and Cascade arc, ZFT (48–9 Ma), ZHe (<15 Ma), AFT (50–4 Ma) and AHe (<45 Ma) data suggest that erosional exhumation began at ~ 18 Ma, probably controlled by Cascade subduction and late Cenozoic episodic glaciation (Brandon et al., 1998; Reiners et al., 2003; Stewart and Brandon, 2004; Michel et al., 2018, 2019).

The distribution of low-temperature thermochronological ages shown in Figure 1.8 reveals a general lack of data across Vancouver Island, a region that is central to all those described above along the northwestern margin of North America. The island’s topography is also different and subdued compared to that of the surrounding Coast and Olympic Mountains. The northern block of Vancouver Island and the Queen Charlotte basin to the north have more subdued topography (Figure 1.9), higher heat flow and higher Bouguer gravity values compared to the southern regions of the island (Lewis et al., 1997; Audet et al., 2008). Whether the exhumation rates of Vancouver

Island reflect similar changes northward or vary with tectonic changes along the boundary has not been studied. To address this knowledge gap, samples were collected for thermochronologic investigations across Vancouver Island from the intrusive rocks of the Jurassic Bonanza Arc and Eocene and younger post-accretionary intrusions (Figure 1.10).

1.5 Geological Setting

The Wrangellia terrane is the basement of Vancouver Island (Figure 1.11), formed during rifting near the paleo-equator in the Late Triassic (Nokleberg et al., 1985). The Wrangellia and Alexander terranes to the north make up the Insular superterrane, which was amalgamated to the western margin of the Intermontane superterrane as one tectonic entity by at least the Middle Jurassic (McClelland et al., 1992; Israel et al., 2014). The Insular superterrane has been interpreted as an island arc that underwent a protracted accretion to the Cordilleran margin from the mid-Jurassic to mid-Cretaceous, and was translated northward within a dextral strike-slip system along the margin from the late Jurassic to early Cretaceous (McClelland et al., 1992).

The Wrangellia terrane on Vancouver Island is characterized by Devonian arc rocks (Sicker Group) overlain by Permian siliciclastic and carbonate rocks (Buttle Lake Group), Middle to Late Triassic flood basalts (Karmutsen Formation), Late Triassic carbonates (Quatsino Formation), and Late Triassic to Early Jurassic carbonate and volcanoclastic rocks (Parson Bay Formation) (Figure 1.12) (Muller, 1977; Canil et al., 2010; Greene et al., 2010). This substrate was built upon by the Jurassic Bonanza arc between 205 and 165 Ma on Vancouver Island (Canil et al., 2013; Canil and Morris, 2024) and in the Haida Gwaii to the north (Lewis et al., 1991). Thickness estimates from geobarometry and field geology indicate the Bonanza arc comprises three

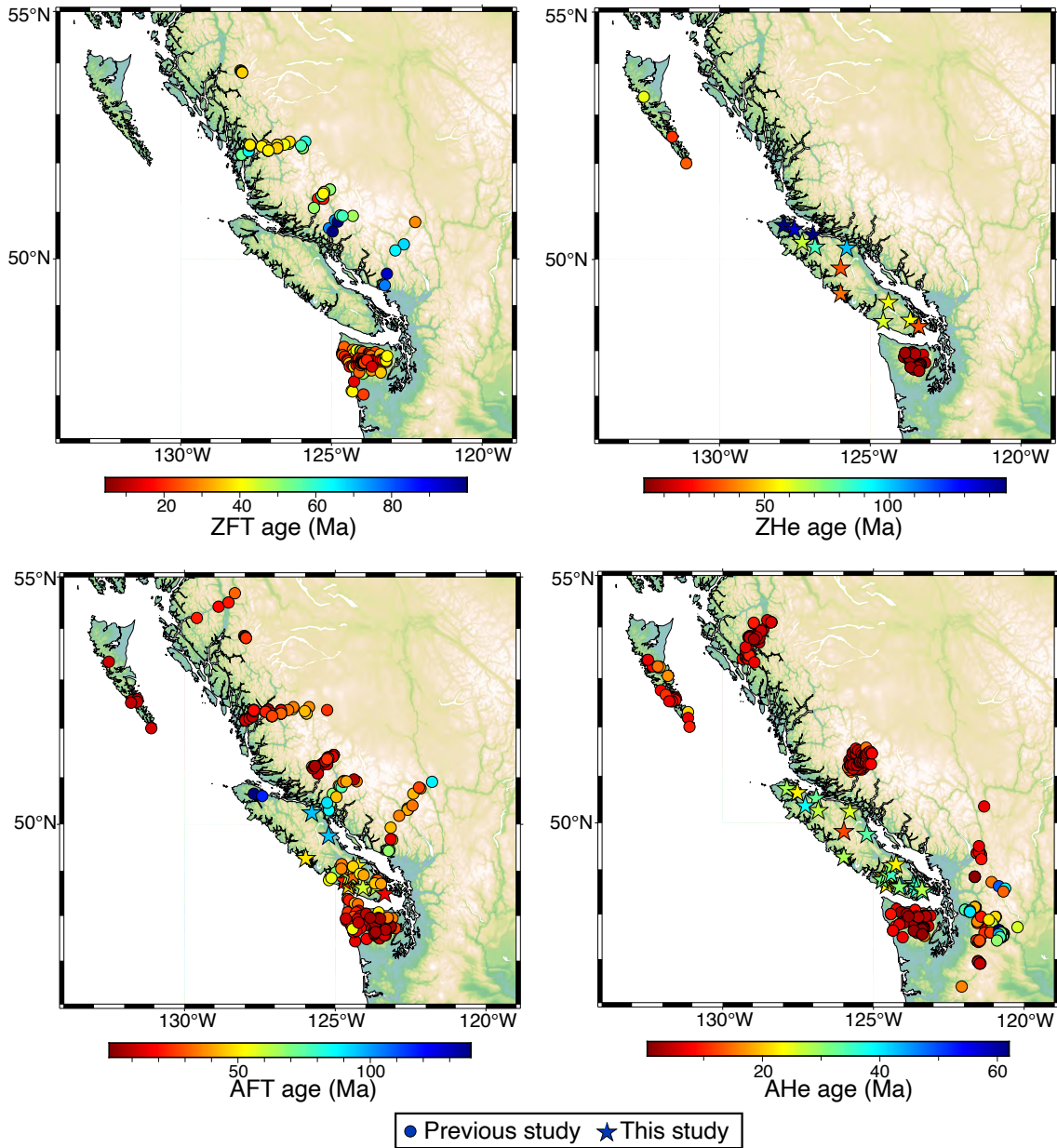


Figure 1.8: Map showing distribution of ZFT, ZHe, AFT and AHe ages along the continental margins surrounding Vancouver Island, compiled from several studies (Parrish, 1983; O’Sullivan and Parrish, 1995; Currie and Grist, 1996; England et al., 1997; Brandon et al., 1998; Farley et al., 2001; Reiners et al., 2003; Ehlers et al., 2006; Densmore, 2008; Michel et al., 2018, 2019; Schoettle-Greene et al., 2020; Currie and Grist, 2024; Qiao et al., 2024). Circle symbols indicate data from previous studies, and star symbols show data acquired in the projects of this study.

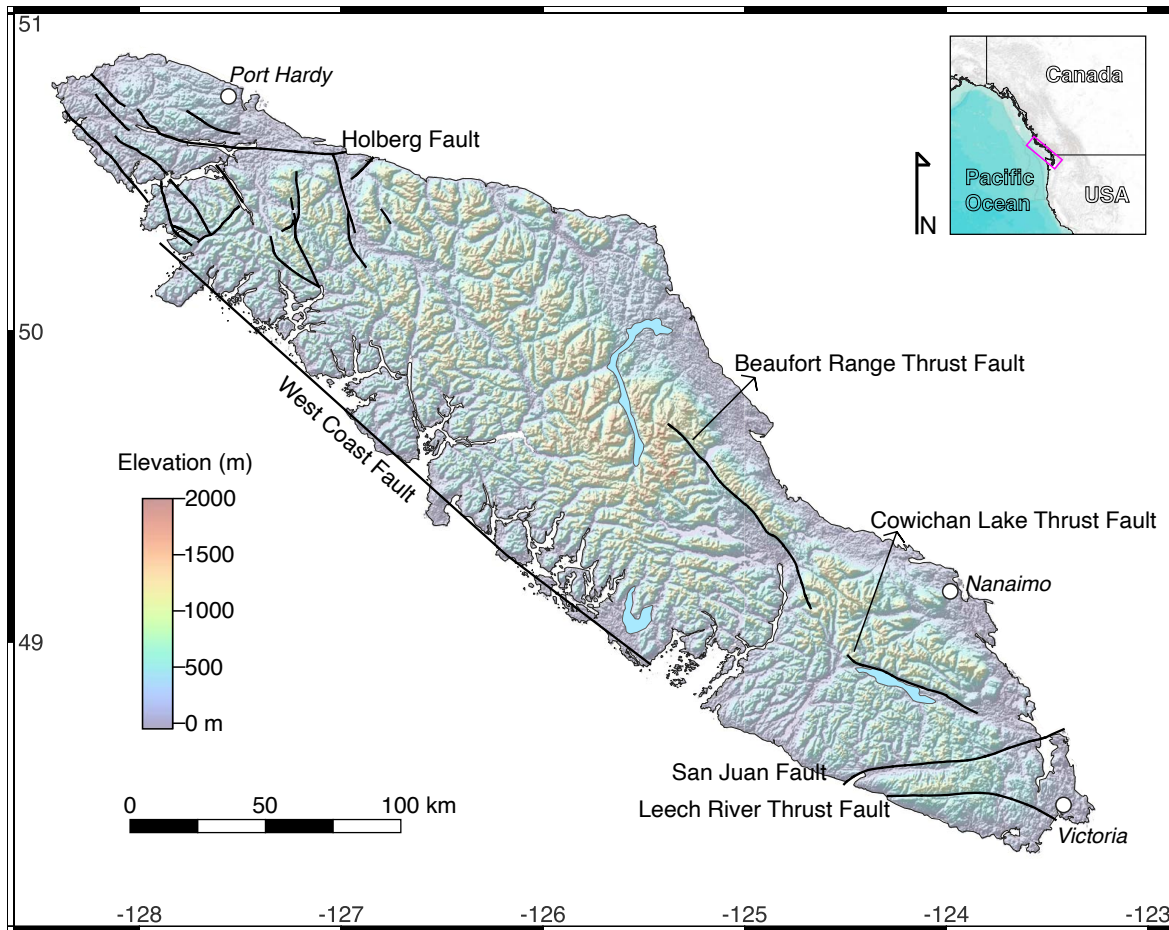


Figure 1.9: Topographic map and locations of major faults in Vancouver Island. Topography is from the Shuttle Radar Topography Mission (SRTM).

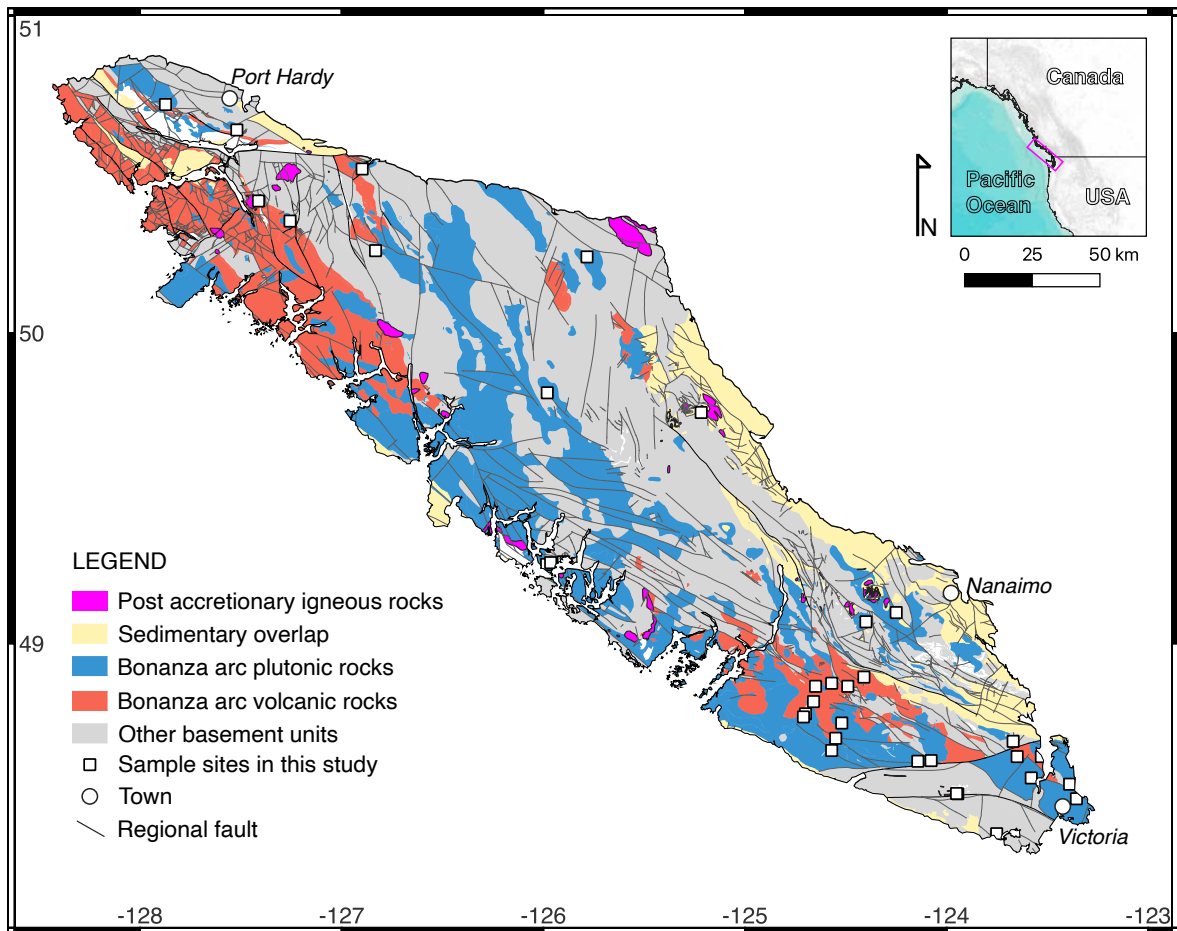


Figure 1.10: Lithology map of Vancouver Island showing only basement rocks of the Jurassic Bonanza arc and overlapping sedimentary rocks and Cenozoic igneous rocks. Geologic unit boundaries and faults are from the British Columbia Geological Survey (BCGS) dataset (Massey et al., 2005; Cui et al., 2017). Samples sites in the three projects of this study are shown with square symbols. The inset map outlines the location of the study region in North America.

crustal units (Figure 1.12): the lower Westcoast Crystalline Complex (10–18 km), the mid-crustal Island Plutonic Suite (2–10 km), and the upper Bonanza Volcanic Group (Muller, 1977; Isachsen, 1987; Canil et al., 2010).

Late Jurassic block faulting was prevalent in the Wrangellia terrane in the Queen Charlotte region, leading to differential uplift and erosion across the northwest-trending faults (Lewis et al., 1991). Extensional tectonics from the Late Cretaceous to Paleogene led to the formation of basins that accumulated extensive marine sediments, sourced primarily from the Coast Mountain Batholith and North Cascades (Dehler et al., 1997). Provenance data indicate two basin-wide sedimentation events, one at ~ 84 Ma likely related to the onset of Kula-Farallon spreading, and the other at ~ 72 Ma possibly related to an increased subduction rate and obliquity (Coutts et al., 2020). These sediments formed the late Cretaceous Queen Charlotte Group exposed mostly on Haida Gwaii, and the Late Cretaceous to Paleogene Nanaimo Group, exposed on Vancouver Island and the San Juan Islands (Figure 1.12) (Lewis et al., 1991; Lyatsky and Haggart, 1993; Nixon and Orr, 2007; Matthews et al., 2017; Coutts et al., 2020; Sproule, 2024).

In the early Cenozoic, the ancient Kula / Resurrection and Farallon plates were subducting beneath the Wrangellia. Plate boundary reorganization occurred at 50–40 Ma at the Kula/Resurrection-Farallon ridge intersection (Figure 1.1) (Madsen et al., 2006; Wells et al., 2014; Clennett et al., 2020; Fuston and Wu, 2021). This induced near-trench magmatism along the margin, formation of two oceanic plateaus around the ridge, initiation of the Juan de Fuca plate subduction and Cascadia margin south of the ridge (Madsen et al., 2006; McCrory and Wilson, 2013; Ten Brink et al., 2018; Fuston and Wu, 2021; Miller et al., 2023). North of the ridge–trench intersection, the Queen Charlotte–Fairweather transcurrent zone developed (Fuston and Wu, 2021). Eocene near-trench magmatism added several igneous units to Vancouver Island, including the Walker Creek intrusions in the Pacific Rim terrane, and the Flores volcanics along with

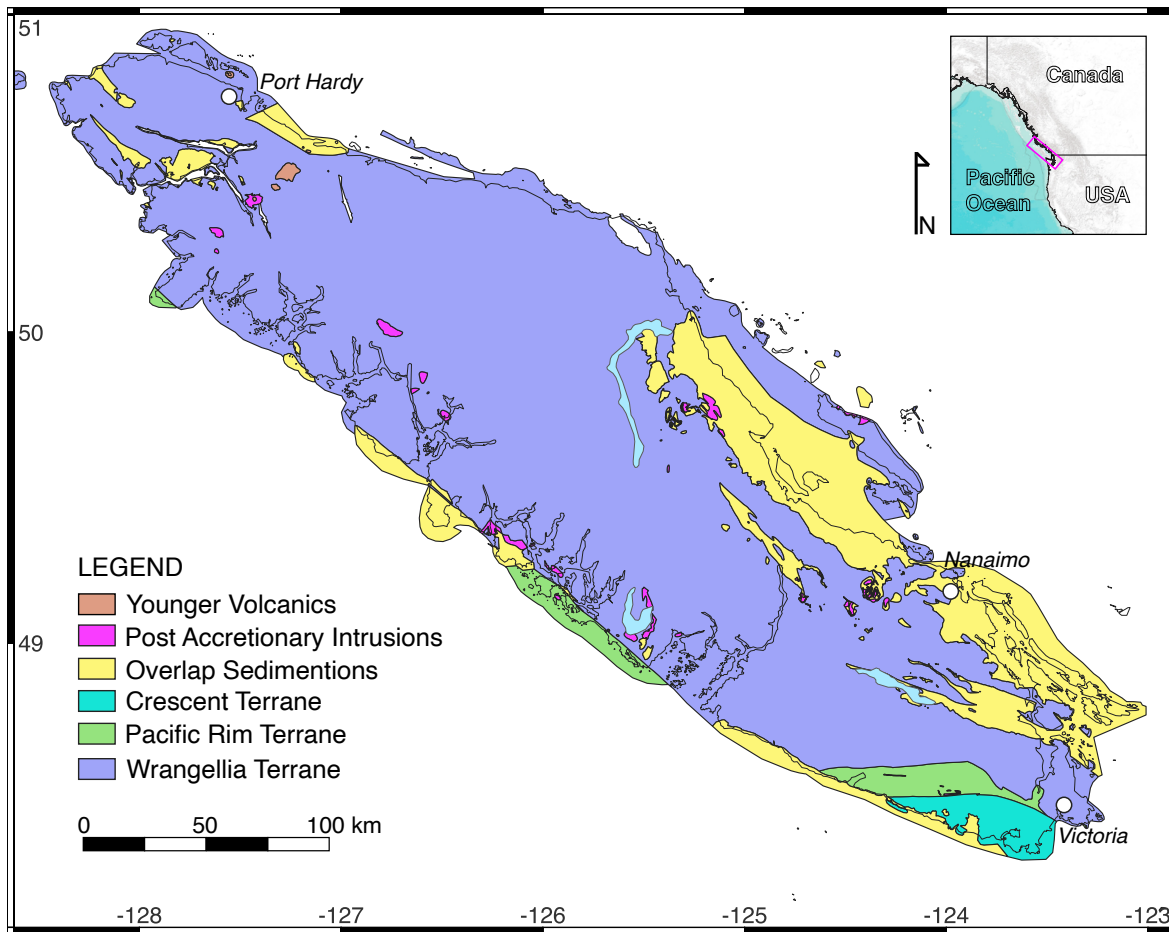


Figure 1.11: Simplified terrane map of Vancouver Island. Terrane boundaries based on map of Geological Survey of Canada (GSC) (Wheeler et al., 1991). The inset map outlines the location of the study region in North America.

the Clayoquot and Mount Washington intrusions in the Wrangellia terrane (Madsen et al., 2006). Clastic sedimentary strata of the Carmanah Group have been deposited along the west coast of Vancouver Island since the Eocene (Figure 1.12) (Seyler et al., 2022). On northern Vancouver Island, the late Neogene Alert Bay volcanic and Klaskish plutonic suites represent the youngest igneous units (Figure 1.12), formed above the subducted boundary separating the Explorer and Juan de Fuca plates (Armstrong et al., 1985; Nixon et al., 2019).

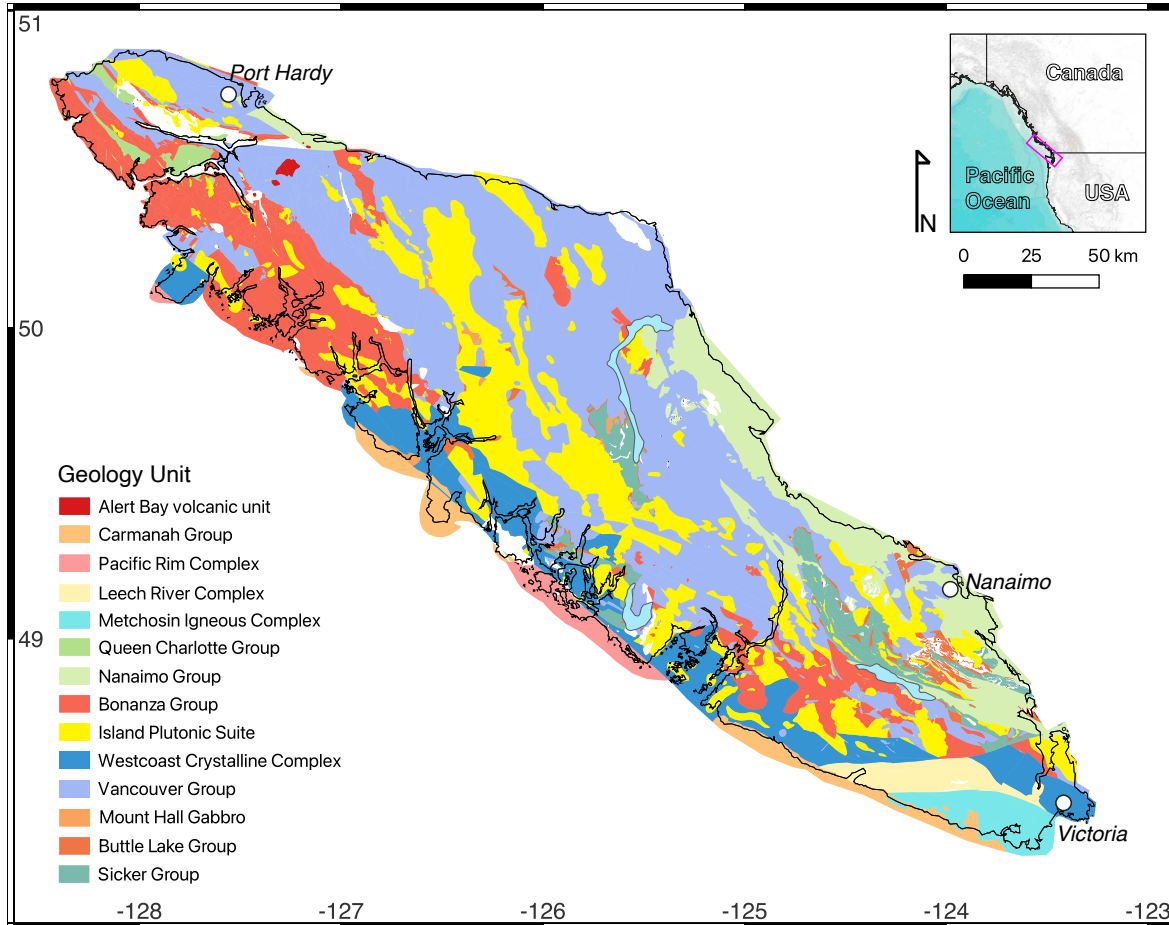


Figure 1.12: Regional geology of Vancouver Island showing geology units exposed on the island. Geologic unit boundaries are from the British Columbia Geological Survey (BCGS) dataset (Massey et al., 2005; Cui et al., 2017). The inset map outlines the location of the study region in North America.

1.6 Dissertation Outline

This thesis is organized into five chapters to address the research objectives. For each of the chapters below I give a brief summary of the main focus.

Chapter 1 outlines the research objectives and structure of the thesis. The chapter also provides necessary background, including thermochronology fundamentals, the geology setting of Vancouver Island, and a summary of existing thermochronological data for the region.

Chapter 2 presents new AFT and AHe data from bedrock samples across southern Vancouver Island. Age analyses and thermal history modeling reveal variable cooling patterns since the late Cretaceous: accelerated Eocene cooling along the major thrust faults, uniform slow cooling in the central region, and prolonged quiescence followed by slow cooling on the west coast. Potential drivers for the rock uplift and exhumation patterns are interpreted and discussed.

Chapter 3 expands the geographic scope to northern Vancouver Island. A multi-method thermochronologic approach (AHe, AFT, ZHe) is used to reconstruct Eocene oceanic plate geometry and dynamics along the northwestern North American margin. Inverse models show prolonged thermal quiescence before 40 Ma in the northernmost region, contrasted with fast exhumation slowing after ~ 50 Ma in the main part of the island. The results are investigated to constrain the northern extent of the Eocene Cascadia subduction zone.

Chapter 4 tests the applicability of zircon Raman dating as a new low-temperature thermochronometer (closure temperature 260–370 °C) using intrusive rock samples of Vancouver Island with distinct and well-constrained thermal histories,

including rapid cooling, multi-stage cooling, and prolonged residence within the zircon Raman partial annealing zone.

Chapter 5 synthesizes the key findings on the exhumation history of Vancouver Island presented in the preceding chapters, discusses the limitations of the present study, and suggests directions for future research.

Chapters 2–4 are formatted as manuscripts for publication in international journals. Each follows a standard structure comprising an introduction, geological background, methods, results, discussion, and conclusion. At the time of thesis submission, Chapter 2 has been published in *Tectonophysics* (Qiao et al., 2024), Chapter 3 has been submitted to *Geology*, and Chapter 4 is being prepared for submission. As the first author on all publications, I was primarily responsible for the investigation, formal analysis, data curation, conceptualization, visualization, and the drafting, reviewing, and editing of the manuscripts. My co-authors, including my supervisors (Dante Canil and Ruohong Jiao), contributed through supervision, resource provision, funding acquisition, conceptual guidance, and manuscript review and editing. Appendices I–III provide details of the analytical methods and the single-grain data used in Chapters 2–4.

Chapter 2

Exhumation response to oceanic plateau accretion and oroclinal development: Low-temperature thermochronology study of Wrangellia Terrane on southern Vancouver Island, Canada

2.1 Introduction

The continental margin of the northwestern North American plate is composed mostly of oceanic terranes that collided and accreted to the cratonic ancestral North American plate from the Mesozoic to Cenozoic (Figure 2.1) (Monger et al., 1982; Colpron et al., 2007; Johnston, 2008; Sigloch and Mihalynuk, 2017; Monger and Gibson, 2019). Low-temperature thermochronology offers a tool to examine how the upper plate reacts to accretion and crustal deformation along margins over a million-year scale by providing constraints on the uplift and exhumation history of the accreted terranes (Currie and Grist, 1996; England et al., 1997; Schoettle-Greene et al., 2020). The plate motions along the convergent boundary of northwest North America during the Cenozoic are relatively well known (Madsen et al., 2006; Doubrovine and Tarduno, 2008; DeMets and Merkouriev, 2016; Wells et al., 2014; Fuston and Wu, 2021; Miller et al., 2023) and provide a framework to study the tectonics along the plate boundary and identify exhumation history patterns. From the Paleocene to Eocene, Vancouver Island was at an interesting position, located near the ridge-trench triple junction of the Kula-Farallon-North America plates (Madsen et al., 2006; Fuston and Wu, 2021; Miller et al., 2023). In the Eocene, the Siletzia (also named the Siletz-Crescent terrane) and the Yakutat oceanic plateaus formed around this triple junction, after which Siletzia

accreted to the North American Plate (Figure 2.1).

Studies using low-temperature thermochronology on the continental margin of north-west North America between the Olympic Peninsula to southern Alaska (Figure 2.1) provide information about spatiotemporal patterns of exhumation. To the south of Vancouver Island, the Olympic Peninsula region has two main units, the Siletzia and Olympic Subduction Complexes. The latter unit is the exposed part of Cascadia accretionary wedge and accumulated from the Eocene to Miocene sourced from the Cascade arc further inland, based on zircon fission track (ZFT) ages (Brandon and Vance, 1992). Studies of fission track and (U-Th-Sm)/He dating of apatite (AFT, AHe) and zircon (ZHe) of sandstones in Olympic Subduction Complexes suggest that erosional exhumation began at ~ 18 Ma and reached a steady state by ~ 14 Ma, although the exhumation rate was affected by short-timescale glaciation (Brandon et al., 1998; Batt et al., 2001; Michel et al., 2018, 2019). On Vancouver Island, AFT ages measured along Alberni Inlet and the Cowichan Fold and Thrust Belts (Figure 2.2) are interpreted as records of a steady cooling process reflecting crustal contraction during Eocene to early Oligocene terrane accretion (Currie and Grist, 1996; England et al., 1997). Further north along the margin, a single study on Haida Gwaii using AHe, AFT, and ZHe methods (Schoettl-Greene et al., 2020) reported mainly Oligocene and Miocene ages which the authors attributed to fast exhumation (>0.2 mm/yr) and shortening of the continental margin driven by the translation of Yakutat. Further north, a few studies along the Fairweather corridor revealed rapid Neogene exhumation associated with transpressive motion of Yakutat and glacial erosion (McAleer et al., 2009; Lease et al., 2021). Another study of the inboard Wrangellia Composite terrane in southern Alaska suggested that tectonic exhumation was caused by Yakutat indentation commencing ~ 10 Ma (Figure 2.1) (Enkelmann et al., 2017).

In this study, I report new AFT data and the first set of AHe ages for 16 Jurassic

crystalline bedrocks of Wrangellia on southern Vancouver Island (Table 2.1). The new data are compared to previous thermochronology studies to identify spatial and temporal patterns of exhumation. Specifically, I address hypotheses that: (1) the translation of Yakutat along a mainly strike-slip plate boundary caused a significant exhumation response along the margin (Schoettle-Greene et al., 2020), (2) slab window formation and near-trench magmatism (Madsen et al., 2006; Thorkelson et al., 2011) caused localized heating, and (3) oroclinal bending (Johnston and Acton, 2003; Finley et al., 2019) or subduction initiation is reflected in the cooling history of southern Vancouver Island. Given that terrane translation, slab window and orocline development are common to many other continental margins, the mechanism I investigated for Vancouver Island may be of general applicability to other similar tectonic settings.

2.2 Geological Background

2.2.1 Cenozoic Tectonics of Northwest North America

The modern ocean-continent plate boundary from Canada to Alaska changes northward from convergent near Vancouver Island and the Olympic Peninsula, to transpressive along the Queen Charlotte-Fairweather Fault System, to convergent in the Chugach-St. Elias Mountain Range where it meets the Aleutian-Alaska Subduction Zone (Figure 2.1). The Cenozoic tectonic evolution of the ocean-continent margin of northwestern North America has been reconstructed using many approaches (Madsen et al., 2006; Wells et al., 2014; Eddy et al., 2017; Fuston and Wu, 2021; Miller et al., 2023). Prior to ~ 53 Ma, the margin experienced mainly oblique convergence and flat subduction of the Kula and Farallon plates beneath the North American plate (Fuston and Wu, 2021). By 50 Ma, two oceanic plateaus formed and straddled the Kula-Farallon ridge with paleolocation near the present-day southern Vancouver Island. The subduction of the

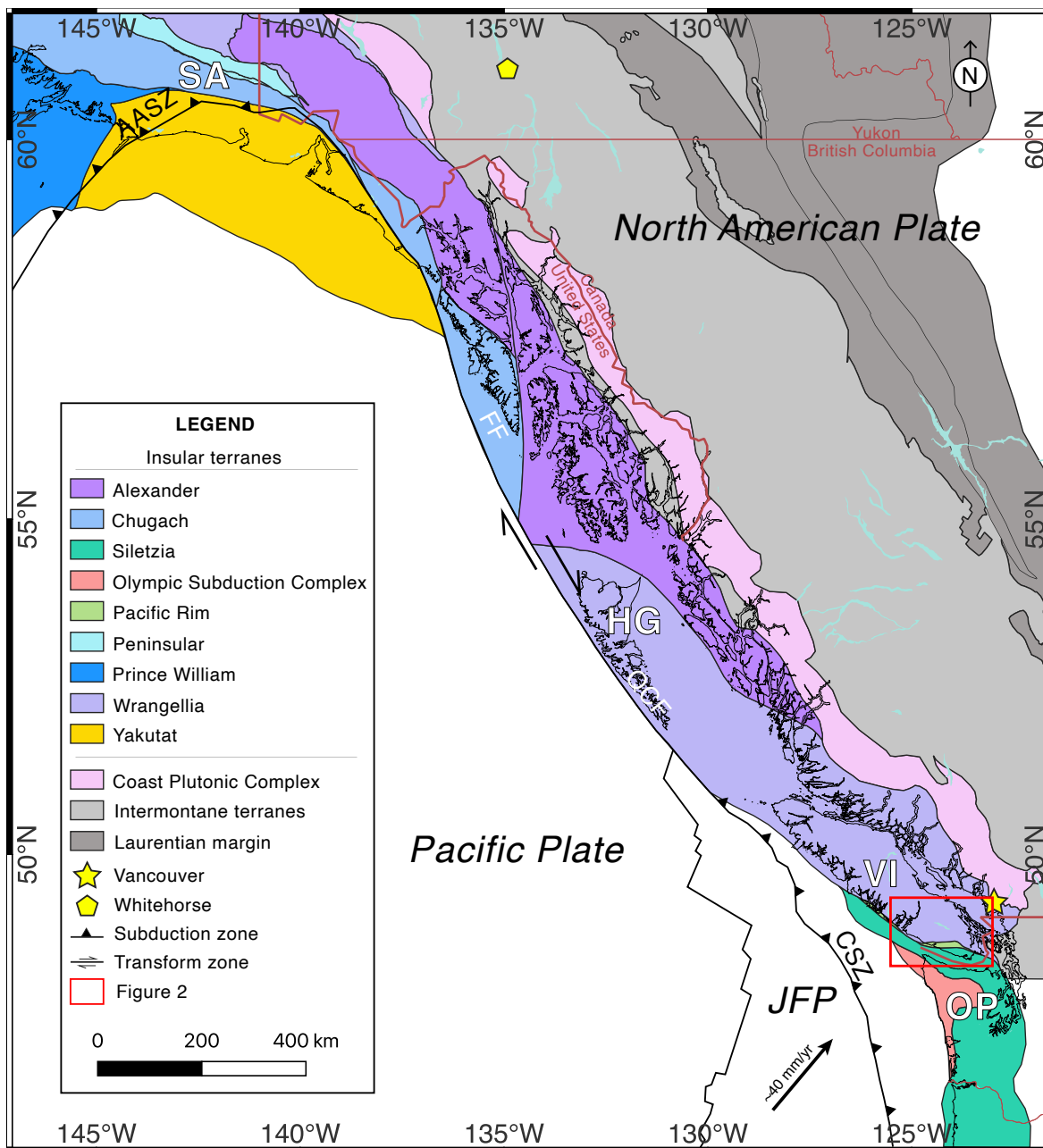


Figure 2.1: Map showing current tectonic setting and accreted terranes along the western margin of North America from the Olympic Peninsula (OP) to southern Alaska (SA) (modified from terrane map of Geological Survey of Canada (Wheeler et al., 1991), digital atlas from Colpron and Nelson (2011)). The Olympic Peninsula, Vancouver Island (VI), Haida Gwaii (HG) and southern Alaska are continental margins along the plate boundary (black line). The thick black arrow shows Juan de Fuca-North America plate motion at present (DeMets et al., 2010). JFP: Juan de Fuca Plate, CSZ: Cascadia Subduction Zone, QCF: Queen Charlotte Fault, FF: Fairweather Fault, AASZ: Aleutian-Alaska Subduction Zone.

ridge beneath the continent generated near-trench magmatism along the margin (Glassley, 1974; Davis and Plafker, 1986; McCrory and Wilson, 2013; Ten Brink et al., 2018; Miller et al., 2023). The two oceanic plateaus then followed different translation paths. One plateau, Siletzia, accreted to the continent, causing Eocene to Oligocene oroclinal bending and rotation of southern Vancouver Island (Johnston and Acton, 2003). Oroclinal bending buckles or flexes the crust to form orogenic belts in a horseshoe or elbow shape (Carey, 1955). The other plateau, Yakutat, translated northward with the Kula and then the Pacific plate to converge with Alaska (Engebretson, 1985; Wells et al., 2014; Ten Brink et al., 2018). The sequence involving ridge subduction, terrane accretion, and translation was followed by the cessation of subduction, the establishment of Queen Charlotte-Fairweather transcurrent boundary, and the opening of a slab window beneath British Columbia (Madsen et al., 2006; Ten Brink et al., 2018; Fuston and Wu, 2021). By 48 Ma, the ancestral Cascadia Subduction Zone formed outboard of Siletzia after the Kula-Farallon-North America triple junction shifted southward (Haeussler et al., 2003; Miller et al., 2023). The initiation of subduction was accompanied by the development of the Olympic orocline and the formation of an accretionary wedge underneath the Olympic Peninsula, which has undergone rapid exhumation since ~ 18 Ma (Brandon et al., 1998; Batt et al., 2001).

Because the crust beneath Vancouver Island was located near the Kula-Farallon ridge subduction zone ~ 50 Ma ago, its evolution was potentially influenced by both the northward translation of Yakutat and the accretion of Siletzia (Engebretson, 1985; Wells et al., 2014; Ten Brink et al., 2018; Miller et al., 2023). To the north near Haida Gwaii, crustal extension, subsidence of the Queen Charlotte basin and forearc magmatism occurred during the Eocene and Miocene (Anderson et al., 1991; Irving et al., 1992; Hyndman and Hamilton, 1993; Irving et al., 2000; Madsen et al., 2006). Further north, the subduction of the wedge-shaped Yakutat since ~ 30 Ma (Brueseke

et al., 2019) affected strain partitioning along the Alaska Range of the Denali Fault (Rusmore et al., 2001; Fitzgerald et al., 2014), and caused significant exhumation and seismicity in the St. Elias Mountains in Alaska (Gulick et al., 2007; Worthington et al., 2012; Enkelmann et al., 2017).

2.2.2 Vancouver Island Geology

Vancouver Island is located at the northern end of the Cascadia Subduction Zone which transitions to a transform margin along the Queen Charlotte Fault (Figure 2.1). Three main terranes make up Vancouver Island: Wrangellia, Pacific Rim and Siletzia, which are separated mainly by the San Juan and Leech River Faults, respectively (Figure 2.2). Wrangellia consists of a Devonian island arc, Permian carbonate platform, Triassic oceanic plateau and limestone, intruded or overlain by the Jurassic Bonanza island arc (Nixon and Orr, 2007; Canil et al., 2010; Canil and Morris, 2024). Wrangellia is in fault contact to the south with the Pacific Rim terrane, a mostly metasedimentary assemblage with a Jurassic-Paleocene protolith age that was metamorphosed to up to amphibolite facies. The terrane was accreted to Wrangellia by ~ 52 Ma based on emplacement age of the intrusions and exhumed by ~ 45 Ma based on $^{40}\text{Ar}/^{39}\text{Ar}$ muscovite and biotite ages in schists (Groome et al., 2003; Wells et al., 2014; Seyler et al., 2022; Geen and Canil, 2023). Shortly after its formation at ~ 52 Ma, Siletzia underthrust the Pacific Rim terrane (Eddy et al., 2017), causing oroclinal bending and development of the Cowichan Fold and Thrust Belt (Johnston and Acton, 2003). Both the Leech River Fault and the San Juan Fault are thought to have accommodated the collision and accretion of Siletzia to the North American plate (Rusmore and Cowan, 1985; Harrichhausen et al., 2022). On Vancouver Island, the three main terranes are overlain along the west coast by clastic sedimentary rocks of the Eocene and younger Carmanah Group, and by Cretaceous - Paleocene Nanaimo Group along the east coast

(Seyler et al., 2022).

2.3 Methods

2.3.1 Samples

I focused our study on apatite in igneous lithologies with well-constrained crystallization ages. I determined AFT and AHe ages of sixteen felsic-intermediate igneous rocks from the Jurassic Bonanza Arc of Wrangellia on southern Vancouver Island. The samples are divided into the lithologies of the Bonanza Volcanics (202–165 Ma), Island Plutonic Suite (180–167 Ma) and West Coast Complex (195–180 Ma) (Table 2.1) (DeBari et al., 1999; Canil et al., 2013; Canil and Morris, 2024). To complement two previous AFT studies for southern Vancouver Island (Currie and Grist, 1996; England et al., 1997), I sampled an understudied region southwest of Barkley Sound and the Cowichan Fold and Thrust Belt, and measured AHe ages to constrain younger thermal history. Ten samples (JL) are located near Nitinat Lake, southwest of the Cowichan Lake Thrust Fault. Two samples (DC) are in the eastern Cowichan Fold and Thrust Belt, overlapping the location of previous work. Four other samples (VI) are south of the belt (Figure 2.2).

2.3.2 Low-Temperature Thermochronology Methods

(U-Th)/He thermochronology is based on Helium production from radioactive alpha decay of U, Th and Sm. The present-day ratio of parent (U, Th, Sm) and daughter (He) isotopes allows calculation of an age corresponding to when a mineral cooled below a characteristic temperature (i.e., closure temperature) when little radiogenic He is diffused out from the crystal lattice. Fission tracks are lattice damage produced by spontaneous fission of ^{238}U . Similarly, the present radiogenic fission track density and

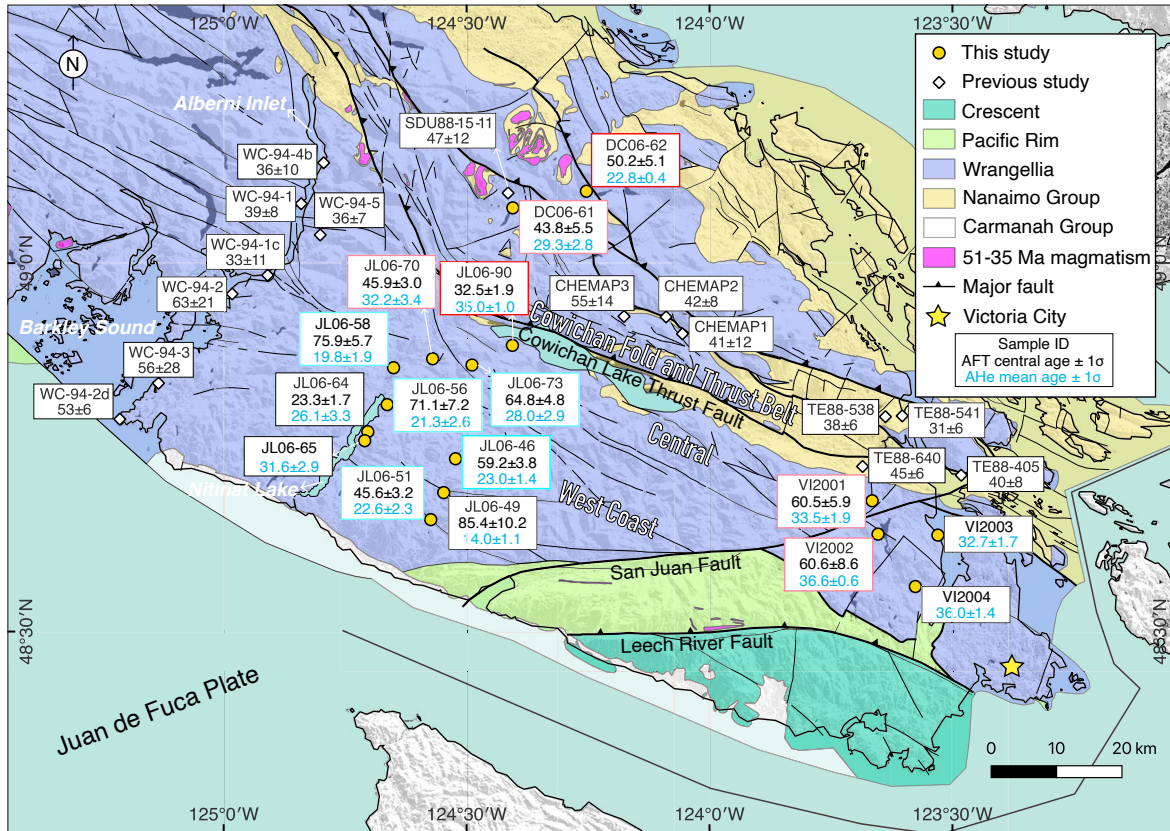


Figure 2.2: Geology of the study area on southern Vancouver Island showing the Wrangellia, Pacific Rim and Crescent terranes, separated by the San Juan and Leech River Faults, respectively. The thick black lines mark major thrust faults (Massey et al., 2005; Cui et al., 2017). The Cowichan Lake Thrust Fault is a major fault which separates the eastern Cowichan Fold and Thrust Belt and the West Coast to Central region. The magenta unit shows 51–35 Ma near-trench intrusions. The yellow circles and the white diamonds show the locations of the samples in this study and from previous work, respectively (Currie and Grist, 1996; England et al., 1997). AFT central and AHe mean ages with 1σ error are labeled in black and blue. The edges of sample boxes are labelled with line colors indicative of overall cooling patterns depicted in Figure 2.3: blue - cooling since Oligocene, pink - uniform cooling, red - accelerated Eocene cooling. Other important locations are labelled in white on the map.

U content determine an age just below the closure temperature when little annealing of tracks occurs in the mineral system. The closure temperature ranges of AHe, AFT, ZHe and ZFT methods assuming typical cooling rates and crystal sizes are around 30 to 90 °C (Zeitler et al., 1987; Farley, 2000; Gautheron et al., 2009), 60 to 120 °C (Wagner, 1968; Naeser and Faul, 1969), 160 to 220 °C Reiners et al. (2004); Reiners (2005); Guenthner et al. (2013) and 190 to 290 °C (Yamada et al., 1995; Tagami, 2005; Bernet, 2009), respectively.

Apatite crystals were separated and concentrated from crushed rocks using magnetic and heavy liquid methods. After rock crushing and mineral separation, 5 to 10 euhedral and relatively large grains were selected for each sample under a stereomicroscope. The selected grains do not contain solid or liquid inclusions, internal fractures or surficial discoloration. The AHe measurements were carried out at the Institute of Geology China Earthquake Administration in Beijing, China, following the procedure described by Wang et al. (2017). Helium isotopes were measured by Alphachron He Isotope mass spectrometer with laser heating and isotope dilution methods. The U and Th concentrations were measured with the isotope dilution method by an Agilent 7900 ICP-MS. I used Durango as the secondary mineral standard (specific dissolution protocol in Wang et al. (2017)).

In the AFT measurements, the samples were etched in 5.5 mol/L HNO₃ for 20s at a temperature of 21°C. Apatite grains were irradiated with ²⁵²Cf at the GeoSep Services in Moscow, USA to enhance the number of measurable confined track lengths from below 30 to mostly over 90 lengths. Stacks of high-resolution digital images of the fission tracks were captured with 100× dry objective and a highly sensitive and fast iDS camera using the Zeiss Axio Imager M2m microscope equipped with the TrackWorks software in The Institute of Geology and Geophysics, Chinese Academy of Sciences (IGGCAS) in Beijing, China. Track densities and confined track lengths

were measured on the images using the FastTracks software. The U concentration of apatite was measured by laser ablation ICP-MS. The method used an Agilent 8800 ICP-MS operated in single quadrupole mode at the University of Victoria coupled to a Cetac LSX-213 G2+ Nd-YAG laser with Hel-Ex 2 sample cell laser ablation system. Parameters were set at 4.08 J/cm² fluence, a firing repetition rate of 6 Hz and a 30 μ m beam diameter in spot mode. ²³⁸U concentrations were calibrated against NIST611, NIST613, NIST615 standard glasses and compared with Durango apatite. Data reduction was performed using LAtools (Branson et al., 2019) with ⁴³Ca as an internal standard element, assuming a stoichiometric Ca content of fluorapatite (39.5 wt%). With fission track density and U concentration data, AFT single grain ages, grain date errors and AFT central age for each sample were calculated using an absolute approach (Hasebe et al., 2004) by IsoplotR (Vermeesch, 2017, 2018).

2.3.3 Thermal Modelling

I obtained 13 AFT central sample ages and 16 AHe mean sample ages. The cooling histories for 13 samples with AFT and AHe data from Vancouver Island were simulated using QTQt software (Gallagher (2012), version 5.6.0). The software uses the Bayesian transdimensional Markov Chain Monte Carlo (MCMC) method to obtain an ensemble of thermal history models with the posterior distribution and likelihood, which fit prior assumptions of time and temperature (e.g., from geological constraints). MCMC is an iterative approach with initial iterations exploring the model space and subsequent iterations to approximate the posterior distribution. The transdimensional MCMC method incorporates a penalty for model complexity and thus favors simpler models during sampling (Gallagher, 2012). Multiple thermochronometers of a sample can be combined in the model simultaneously. I used the radiation damage model of Gautheron et al. (2009) and a spherical diffusion domain to simulate the AHe data.

For the ZHe data, I used the radiation damage model of Guenthner et al. (2013). I use Dpar data as the compositional proxy of apatite, and multi-compositional algorithms of Ketcham (2019) to predict fission track ages and length distributions. I input AFT single grain ages with 1σ standard error and AHe isotope contents with grain dimensions. I set the general inverse priors for a sample considering both AFT and AHe dates and conventional closure temperature ranges. A time-temperature (t-T) box (180 ± 20 m.y., 850 ± 50 °C) is prescribed for the modeling, which encompasses the known zircon U-Pb ages for Bonanza arc samples in the study area (Canil et al., 2010; Canil and Morris, 2024) and the closure temperature range (Lee et al., 1997). Present-day temperature is assumed as 10 ± 10 °C. Our early experiments (Figure A.7) show that allowing reheating in the history could lead to very recent rapid cooling and minor heating during $\sim 60\text{--}40$ Ma, which are inconsistent with the current understanding of the region’s geological history. Thus, in our preferred models presented here, all temperature-time paths are forced to be monotonically increasing. Burn-in and post-burn-in iterations in the MCMC chain were set to be 50000 and 100000, respectively, for all samples.

Table 2.1: Summary of sample information, ages and uncertainties

Sample	Lat (°)	Long (°)	Elev- ation (m)	Lithology	Suite ^a	AHe grain No ^b	AHe mean1 (Ma) ^c	1 σ^d AHe mean2 (Ma) ^e	1 σ^d AHe pooled3 (Ma) ^f	2 σ^d AHe grain No ^g	AFT (Ma) ^h	1 σ^d AFT length No ^j	MTL (μm) ^k	1 σ^d
West Coast - Nitinat zone														
JL06-46	48.74	-124.52	342	Granodiorite	IPS	8	23.0	1.4	23.0	3.0	59.2	3.8	10.2	0.8
JL06-49	48.69	-124.55	305	Andesite	BONV	8	19.8	5.0	19.8	10.0	85.4	10.2	N.D.	N.D.
JL06-51	48.65	-124.57	246	Granite	IPS	8	22.6	2.3	22.6	4.0	45.6	3.2	9.6	1.2
JL06-56	48.81	-124.66	72	Andesite	BONV	5	24.9	4.1	24.9	7.0	71.1	7.2	12.6	1.3
JL06-58	48.86	-124.65	21	Andesite	BONV	5	19.8	1.9	19.8	3.0	75.9	5.7	12.4	0.8
JL06-64	48.77	-124.70	305	Granodiorite	IPS	5	26.1	3.3	26.1	7.0	23.3	1.7	11.3	0.4
JL06-65	48.76	-124.71	272	Granite	IPS	5	31.6	2.9	31.6	8.0	N.D. ^l	N.D.	N.D.	N.D.
Central - Cowichan Fold and Thrust Belt zone														
JL06-70	48.87	-124.57	177	Granodiorite	WCC	5	32.2	3.4	32.2	6.0	45.9	3.0	12.5	0.6
JL06-73	48.86	-124.49	495	Andesite	BONV	5	28.0	2.9	28.0	6.0	64.8	4.8	13.1	0.7
JL06-90	48.89	-124.41	322	Andesite	BONV	5	35.1	1.0	35.0	2.0	32.5	1.9	13.9	0.4
DC06-61	49.07	-124.40	336	Granodiorite	IPS	4	29.3	2.8	29.3	1.0	43.8	5.5	10.0	1.0
DC06-62	49.10	-124.25	275	Granodiorite	IPS	5	22.8	0.4	22.8	0.8	50.2	5.1	13.6	0.4
VI2001	48.68	-123.67	94	Diorite	IPS	5	33.5	1.9	33.5	3.0	60.5	5.9	14.6	0.4
VI2002	48.63	-123.65	162	Diorite	WCC	4	36.6	0.6	36.6	1.0	60.6	8.6	15.6	0.4
VI2003	48.63	-123.53	13	Diorite	IPS	7	32.7	1.7	32.7	4.0	N.D.	N.D.	N.D.	N.D.
VI2004	48.56	-123.58	298	Diorite	WCC	8	36.0	1.4	36.0	2.0	N.D.	N.D.	N.D.	N.D.

Note: Samples are stored in the collections of the University of Victoria, School of Earth and Ocean Sciences, Victoria, BC V8W 2Y2, Canada.

^aIPS - Island Plutonic Suite. WCC - West Coast Complex. BONV - Bonanza Volcanics.

^bNumber of AHe grains analyzed and used for thermal modeling.

^cArithmetic mean age of corrected AHe grain dates.

^d1 σ or 2 σ standard error for AHe or AFT data.

^eArithmetic mean age of AHe grain dates based on corrected He.

^fThe pooled age of AHe data.

^gThe grain number of AFT samples used for thermal modeling, including counts of repeated U measurements and deleted outliers in radial plots.

^hAFT central age calculated in radial plots.

ⁱArithmetic mean of FT etch pit lengths parallel to the c axis.

^jThe number of track lengths for AFT samples.

^kMTL - Mean Track Length.

^lN.D. = not determined.

2.4 Results

2.4.1 Apatite (U-Th)/He Results

I obtained 92 new AHe single grain dates (Table 2.1 and Table A.1 in the Supplemental Material) and calculated mean ages and pooled ages for 16 samples. I report grain dates corrected for alpha ejection using two approaches: one method corrects the raw dates using the Ft correction factor (Farley, 2002), and the other corrects the He content by the Ft factor to calculate the grain dates (Min et al., 2003; Ketcham et al., 2011). The two types of corrected grain dates are almost identical, varying from 5.4 ± 0.6 Ma to 45.7 ± 3.0 Ma (1σ standard deviation, Table A.1). Arithmetic mean sample ages range from 14.0 ± 2.2 Ma to 36.6 ± 1.3 Ma (2σ standard error, Table 2.1 and Figure 2.2). To determine the effects of grain size and radiation damage on He diffusion and dispersion in AHe grain dates, I plotted the uncorrected date against spherical radius (Rs) and the effective uranium concentration (eU) against corrected date for individual samples (Figure A.1 and A.2) by Incaplot (Härtel et al., 2022a; Härtel, 2023). The uncorrected date-Rs plots for all samples in the study area show a non-linear and scattered pattern with the spherical radii mostly constrained within 30 to 50 μm . This indicates the range of grain sizes in our samples may not be a controlling factor for the scattering of single grain dates. Date-eU plots of most samples show no positive pattern and a low narrow range in eU. Some even show uniform dates with various eU, indicating that the radiation damage has negligible effect on the AHe data. Considering the possibility of spurious age-eU correlation and low discriminatory power of age-eU plot for low amounts of samples (Härtel et al., 2022a), I also plotted the He-eU relation (D-P plot). As shown in Figure A.3, 11 out of 16 samples show a positive and linear He-eU relationship and a good fit between regressive isochron age and pooled age

with a minor systematic offset. Samples JL06-49, -56, -58, -70, and -73 show more scattered and non-linear patterns, indicating increased date dispersion. To account for the possible effects of radiation damage on the sample ages, I used the model of Gautheron et al. (2009) in thermal modelling.

2.4.2 Apatite Fission Track Results

I report 13 new AFT central ages ranging from 23.3 ± 3.4 Ma to 85.4 ± 20.4 Ma (2σ standard error) (Table 2.1 and Table A.2). All but two samples (JL06-64, JL06-90) have AFT central ages that are greater than AHe mean ages. For these two samples, AFT and AHe ages are consistent within 95% confidence intervals, indicating rapid cooling processes. To investigate the intrasample dispersion of AFT dates, I made Kernel Density Estimates (KDE) and radial plots for individual samples by IsoplotR (Figure A.4 and A.5). All samples but one (JL06-73) show a normal or skewed distribution of grain dates and a single age peak in KDE plots. The combined single grain dates of most samples pass the chi-squared tests in radial plots and are consistent with a single age population, with only three (DC06-61, DC06-62 and VI2002) showing p-value lower than 0.05. The radial plot of DC06-61 (Figure A.5) shows that three older grains exhibit larger Dpar values, suggesting an influence of chemical composition on fission track annealing and grain dates (Ketcham, 2019). Sample DC06-62 does not pass the chi-squared test mainly due to two outliers (one abnormally old and one abnormally young grain date). Sample VI2002 shows mainly a continuous age population with no apparent correlation between Dpar and single-grain dates in the radial plots.

After the Cf irradiation, I obtained over 90 confined track length measurements from 12 samples and only 7 measurements from sample JL06-49 (Table A.3). The mean track length (MTL) for the samples ranges from 10.5 to 12.6 μm , with standard deviation (SD) from 1.2 to 1.8 μm (Figure 2.2). The detailed length data and the length

distribution histogram data are reported in Table S3 and Figure A.6, respectively. The MTL and SD ranges suggest the confined tracks of all samples were partially annealed over the thermal history. Relatively lower MTLs of samples in the West Coast region suggest more significant annealing process with either higher temperature or longer annealing time. Most samples exhibit a unimodal length distribution, either normal or slightly left-skewed, while a few samples on the eastern side show a slight bimodal trend (Figure 2.3 and A.6). The length distribution patterns indicate that most samples likely underwent a prolonged period of slow cooling through the partial annealing zone (PAZ).

2.4.3 Thermal History Modelling Results

Our preferred thermal history models of all 13 samples are shown in Figure 2.3. The original thermal history models are provided in the supporting information (Figure A.7), with setup parameters provided in Table A.4. Overall, all samples show a cooling process since the Eocene within the temperature sensitivities of AFT and AHe. The thermal histories reveal three distinct patterns that vary by spatial region (Figure 2.3). The samples on the western side show a common pattern of very slow cooling from 80–70 Ma to ~ 30 Ma, followed by moderate cooling to the surface at a rate of 1.5–2.5 $^{\circ}\text{C}/\text{Myr}$. The cooling rate is estimated from the slope of time-temperature path in thermal models. In the central-eastern area, four samples show uniform slow cooling at a rate of 1.3–1.5 $^{\circ}\text{C}/\text{Myr}$ since at least 60 Ma. In the Cowichan Fold and Thrust Belt, two samples near mapped major thrust faults show accelerated cooling (4–5 $^{\circ}\text{C}/\text{Myr}$.) in the Eocene, followed by 1–2 $^{\circ}\text{C}/\text{Myr}$ slow cooling since ~ 30 Ma to the surface. For comparison, eight models in a previous study in this region that were based on AFT data alone suggested steady moderate cooling of 2–3 $^{\circ}\text{C}/\text{Myr}$ (England et al., 1997). Sample DC06-62 shows a very recent (1 Ma) rapid cooling phase, which

could be an artefact of modelling to account for the shortened track lengths. The track length shortening may have occurred near surface below the PAZ over a geological time scale (Enkelmann et al., 2005), which may not be predicted by the annealing model. Therefore, DC06-62 is most likely to have slowly exhumed to the surface since the Oligocene.

Two outliers deviate from the common patterns described above. The model for JL06-49 shows a later exhumation starting around 20 Ma, most likely related to the small number of grains for the AFT data. Another outlier JL06-64 exhibits a fast-cooling trend in the Eocene and slow cooling since ~ 25 Ma. The fast-cooling phase reflects the similarity in the AFT and AHe ages. The JL06-64 sample shows partial annealed lengths with MTL similar to other nearby samples, not aligned with the age data and model.

In summary, the West Coast region of Wrangellia experienced very limited cooling and was not exhumed until the Oligocene. By comparison, the eastern side of southern Wrangellia experienced accelerated or moderate cooling during the Eocene, and slow-moderate exhumation since the Oligocene. All other thermal history models or time-temperature paths used for regional comparison in the later discussion are from existing studies for southern Alaska, Haida Gwaii and the Olympic Peninsula region (McAleer et al., 2009; Enkelmann et al., 2017; Schoettle-Greene et al., 2020; Lease et al., 2021).

2.5 Discussion

2.5.1 Cenozoic Cooling Patterns

The AFT and AHe ages in this study are mainly Paleocene to Oligocene. The AFT ages in the Cowichan Fold and Thrust Belt are consistent with previous data (Figure 2.2) from the same region (England et al., 1997), albeit more scattered than existing dataset

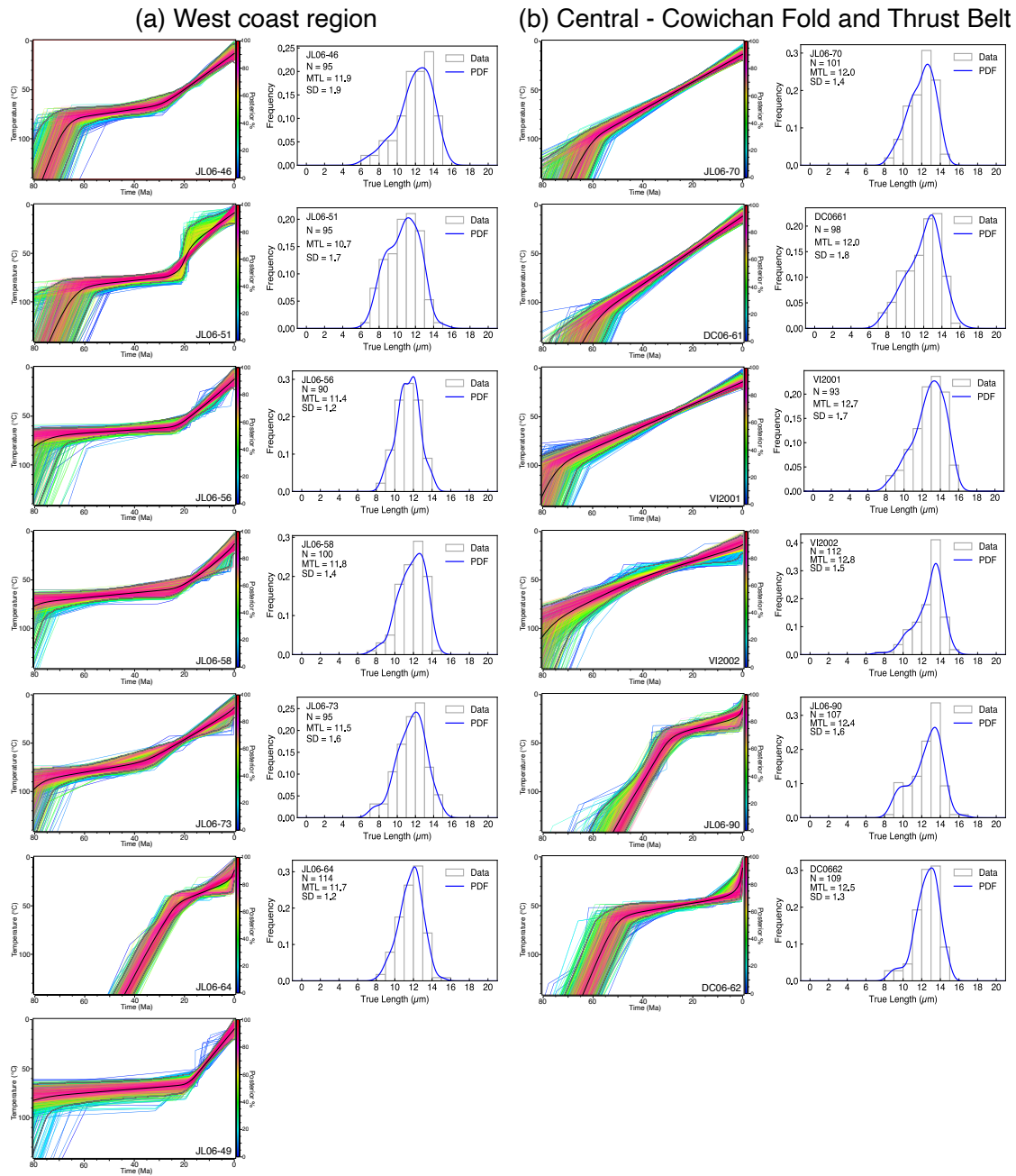


Figure 2.3: Time-temperature paths (or thermal history) modelled by QTQt and length distribution histograms for individual samples in the (A) West coast region and (B) Central-Cowichan Fold and Thrust Belt. The boxes in models indicate the age data, which include the width of AFT central / AHe mean age $\pm 2\sigma$ and the height of nominal closure temperature range (AHe: 40–80 °C; AFT: 60–120 °C; ZHe: 160–220 °C). MTL: mean track length, SD: standard deviation, PDF: probability density function.

in the West Coast region. Currie and Grist (1996) reported eastward younging of AFT ages along Barkley Sound – Alberni Inlet (Figure 2.2). I also observe generally older AFT ages on the west side of the island (Figure 2.4(A)). Except for two samples on the eastern side, I see a trend of increasing AHe ages from the west to the central island (Figure 2.4(B)). Comparison of AFT and AHe age patterns in Figure 2.4 suggests that the west coast of southern Vancouver Island, compared to central-east region, might have experienced a longer time within the AFT and AHe partial annealing or retention zones during the Paleogene and Eocene. Conversely, the eastern Cowichan Folt and Thrust Belt might have experienced an earlier onset of exhumation.

The thermal history modelling results are consistent with the age pattern and confined track length distribution (Figure 2.3). The extended duration of the t-T path within the PAZ in the Eocene, followed by exhumation to surface for samples on the west region, aligns with the shortened track length and the significant AFT and AHe age discrepancy. The small AFT-AHe age difference for samples from the central-eastern island is reflected in the accelerated Eocene cooling of some samples. The limited track length shortening for samples in this area can be explained by the slow cooling within or above the apatite partial retention and annealing zones.

Our thermal history models can be compared on a larger scale with similar low-temperature thermochronology datasets for southern Alaska, Haida Gwaii and the Olympic Peninsula region – all regions of the continental margin of western North America that might have been affected by ridge-trench interaction, Siletzia accretion or Yakutat translation since the Eocene (Currie and Grist, 1996; England et al., 1997; Brandon et al., 1998; McAleer et al., 2009; Enkelmann et al., 2017; Michel et al., 2018, 2019; Schoettler-Greene et al., 2020; Lease et al., 2021). The thermal history of Haida Gwaii samples, modelled solely using AHe ages (Schoettler-Greene et al., 2020) shows mainly a uniform cooling with no change in cooling rate during exhumation. Three out

of five samples modelled with AHe, AFT and ZHe ages show the onset of rapid cooling around 16 Ma (Figure 2.5). The thermal histories of seven samples in southern Alaska along the Fairweather fault all show rapid cooling since after 10 Ma (McAleer et al., 2009). Further inland in the Insular Terranes (Figure 2.1), the onset of rapid cooling varies with distance to plate margin (Enkelmann et al., 2017). Only nine out of 18 samples modelled with AFT, AHe, ZFT and ZHe data show a fast-cooling onset after 10 Ma, indicating limited influence by Yakutat collision coupled flat slab subduction. The AHe, AFT and ZHe ages for the fully reset sedimentary rocks in the core of Olympic Peninsula (Michel et al., 2018, 2019) suggest rapid exhumation of Olympic Peninsula in the past 10 Ma.

The deformation and exhumation of the continental margin of northwest North America may be linked to ridge-trench interaction around the paleo-triple-junction of Kula-Farallon-North America, followed by slab breakoff, collision of Yakutat-Siletzia oceanic plateaus and ridge migration (Madsen et al., 2006; Wells et al., 2014; Fuston and Wu, 2021; Miller et al., 2023). In the following section, I examine several scenarios that can explain the cooling history of southern Vancouver Island in this study and discuss each hypothesis in the context of available thermochronology data.

2.5.2 Exhumation Response to Yakutat Translation?

After its formation, Yakutat began to translate from a paleo-location near southern Vancouver Island to southern Alaska along a strike-slip plate boundary. Schoettle-Greene et al. (2020) suggested that the acceleration in cooling rate around Haida Gwaii, north of Vancouver Island was caused by the translation and transpression of Yakutat at ~ 16 Ma. However, it should be noted that the presently exposed Yakutat is only the southern thicker trailing portion (~ 30 km) of an originally much larger terrane (> 1300 km long) that existed before it was partially subducted (Figure 2.5(A)) (Eberhart-

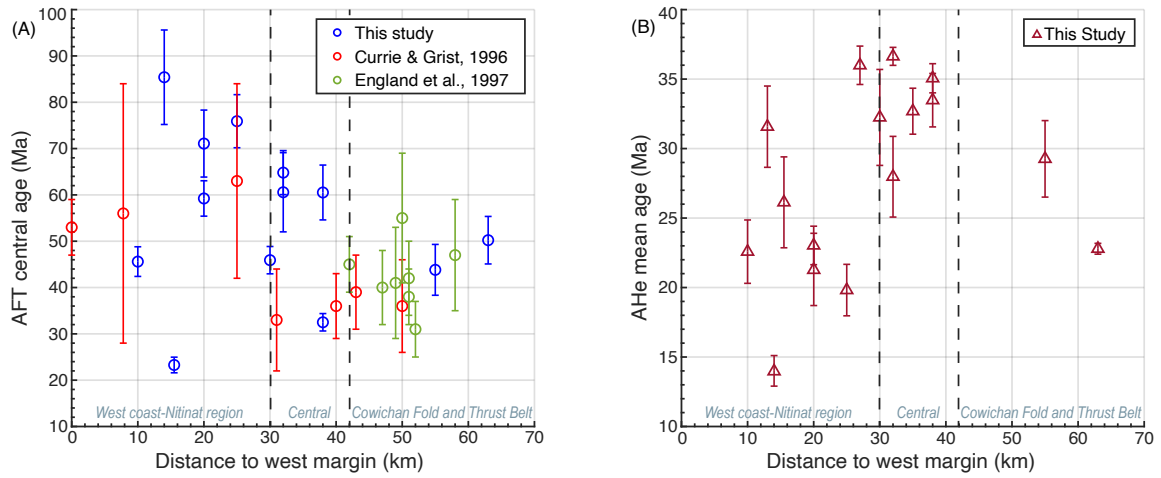


Figure 2.4: AFT central ages (A) and AHe mean ages (B) with 1σ errors in this study and previous studies plotted against the distance to the west coast of Vancouver Island. Note that AFT ages in the Cowichan Fold and Thrust Belt are generally younger than the ages in the West Coast region (except JL06-64). The AHe ages generally increase with increasing proximity to the Central region (except for two samples from the east side).

Phillips et al., 2006; Trop et al., 2022; Worthington et al., 2012; Mann et al., 2022; Trop et al., 2022).

To further test this proposal, I compared the longitudinal translation path of the north and south end of Yakutat, reconstructed based on previous plate models (Dobrovine and Tarduno, 2008; DeMets and Merkouriev, 2016), with the ages (AFT, AHe and onset of cooling) for samples from Vancouver Island, Haida Gwaii and southern Alaska (Figure 2.5(B)). The observed cooling onset of three sites is broadly consistent with the time when Yakutat was proximal, which could be interpreted as an exhumation response along the continental margins to the transpressive motion of Yakutat. However, for samples from both southern Vancouver Island and Haida Gwaii, cooling rate only increased when the southern end of the translating Yakutat passed through and remained steady after the passage (Figure 2.5(B)). Thermochronology data from northern Vancouver Island could help further test this hypothesis, but Yakutat translation cannot explain the spatially different exhumation patterns of the western and eastern regions of southern Wrangellia. Additionally, the mechanism is unclear by which a minor compressive component ($<10\text{mm/yr}$) of northward Yakutat motion could cause substantial crustal shortening across the North American transform boundary during its translation, leading to any substantial exhumation on Wrangellia. Therefore, I do not consider the translation of Yakutat as the principal driver of the exhumation of southern Vancouver Island observed in this study.

2.5.3 Cooling following Near-trench Magmatism or Slab Window Heating?

The ridge-trench interaction near central-south Vancouver Island around 50 Ma has been interpreted to have caused slab window formation and near-trench plutonism from 51–35 Ma (Groome et al., 2003; Madsen et al., 2006; McCrory and Wilson, 2013;

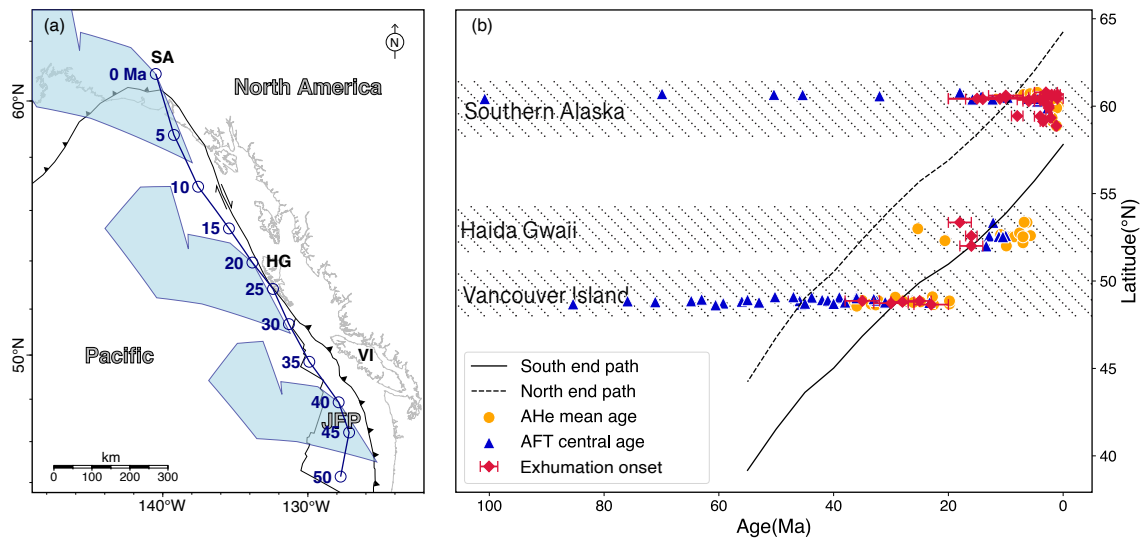


Figure 2.5: (A) The translation history of a middle point along the east boundary of the Yakutat (the blue line) from 45 Ma from south of Vancouver Island to southern Alaska, reconstructed using GPlate (Dobrovine and Tarduno, 2008; DeMets and Merkouriev, 2016). The three blue polygons denote the locations of the reconstructed Yakutat before subduction at 40 Ma, 20 Ma and present. The vertices of the shape were provided by Mann et al. (2022) based on scattered-wave imaging data. JFP: Juan de Fuca Plate, VI: Vancouver Island, HG: Haida Gwaii, SA: southern Alaska. (B) Graph describing the relationship between the latitudinal Yakutat translation and the uplift history of the Cordillera western margin based on thermochronology data. The red diamonds show the observable onset ages of exhumation with uncertainty. The blue triangles and the yellow circles represent AFT central and AHe mean ages, respectively. Source for thermochronology data are: Vancouver Island (this study, Currie and Grist (1996); England et al. (1997)), Haida Gwaii (Schoettle-Greene et al., 2020), southern Alaska (McAleer et al., 2009; Enkelmann et al., 2017; Lease et al., 2021). The solid and dashed lines are the paleo-locations of the southern and northern end of Yakutat during its translation, reconstructed using GPlate according to previous models (sources in A).

Miller et al., 2023) (Figure 2.2). The bedrock within the thermal aureole of these plutons could be heated, (partially) resetting AHe or AFT ages (e.g., Stevens Goddard and Fosdick (2019)). In this study, two samples (DC06-61 and DC06-62) are located within 4 km from 51–35 Ma intrusions, but the AHe cooling ages of these two samples (23 and 29 Ma) are too young to have been influenced by the contact metamorphism. All other samples are located over 20 km away (Figure 2.2). Therefore, I observe no effect of the near-trench 51–35 Ma magmatism on the cooling history of any of our samples.

Slab window formation is linked to thin lithosphere, high surface heat flow and extension of the upper crust (Rohr and Currie, 1997; Madsen et al., 2006; Thorkelson et al., 2011) and could potentially influence some thermochronological ages of the upper crust through asthenosphere upwelling and increase the geothermal gradient of a region. A modern example of this scenario is located around Chilean Patagonia. Stevens Goddard and Fosdick (2019) examined the thermal effect of a Miocene and younger slab window in Patagonia using thermochronology. They concluded that the heat flow generated by the slab window is insufficient to significantly perturb the thermal structure of the upper crust and thus cannot impact low-temperature thermochronological data. Some plate tectonic models (Madsen et al., 2006; Miller et al., 2023) show a paleo-slab window beneath central-southern Vancouver Island during Kula-Farallon ridge subduction between ~ 50 Ma to 45 Ma, after which the ridge shifted southward outboard of Siletzia in Oregon. The potential thermal effect of the paleo-slab window should expand over a broad area, which is not reflected by the spatially different cooling patterns in this study. I see no thermochronological evidence that slab window influenced the thermal structure of the upper crust of southern Vancouver Island.

2.5.4 Exhumation Response to Accretion and Oroclinal Bending

Using structural and paleomagnetic data, Johnston and Acton (2003) proposed an initial bending and later rotation of the crust of southern Vancouver Island, related to the Eocene collision of Siletzia, and coincident with the Kula-Farallon ridge subduction at $\sim 53\text{--}49$ Ma (Miller et al., 2023). Oroclinal bending could be accommodated by crustal shortening in the Cowichan Fold and Thrust Belt. Oroclinal rotation occurred about a pole located northeast of Port Alberni (Figure 2.6(A)), resulting in extensional structures within Barkley Sound and the deposition of Eocene to Oligocene strata in the offshore Tofino Basin (Johnston and Acton, 2003). A later study (Finley et al., 2019) further identified southern Vancouver Island as one limb of the Olympic orocline, an outboard concavity in the upper crust arched around the Olympic Peninsula (Figure 2.6(B)). The origin of the Olympic orocline is debated (Johnston and Acton, 2003; Finley et al., 2019). The published thermochronology data (Brandon et al., 1998; Batt et al., 2001; Michel et al., 2018, 2019) suggest the upper plate at Cascadia including Siletzia has been folded since at least the Miocene (~ 18 Ma) and reached a steady state of erosion and rock uplift since ~ 14 Ma.

The Eocene exhumation pattern of the eastern Cowichan Fold and Thrust Belt is consistent with the oroclinal bending model of Johnston and Acton (2003) (Figure 2.6(A)). Both the accelerated exhumation in the Eocene for two samples close to the major thrust faults (Figure 2.2) and the moderate exhumation of samples in the thrust faults documented by England et al. (1997) reflect an exhumation response to southern Vancouver Island oroclinal bending process, caused by accretion of Siletzia. Furthermore, the AFT ages along the Barkley Sound-Alberni Inlet (Currie and Grist, 1996) show a sudden change from Paleocene ages in the west to late Eocene ages in

the east (Figure 2.6(A)), consistent with an eastward opening of Alberni valley caused by oroclinal rotation as previously proposed by Johnston and Acton (2003).

The ages and thermal models for the West Coast of southern Vancouver Island near Nitinat Lake indicate moderate exhumation beginning ~ 30 Ma. By this time, plate motion reconstructions (Dobrovine and Tarduno, 2008; Miller et al., 2023) show the southern end of Yakutat and Pacific-Farallon ridge had passed north, and the subduction beneath the Cascadia arc was ongoing outboard of the study region (Figures 2.5 and 2.6(A)). The ongoing exhumation of the west-central region beginning from ~ 30 Ma to the present aligns with subduction initiation as the driving motion.

Based on our dataset, no exhumation response is observed on southern Vancouver Island for the rise of the Olympic Mountains to the south and related oroclinal bending since early Miocene (Figure 2.6(B)). This is consistent with a previous hypothesis for a concentration of crustal shortening only within the Olympic core with less deformation on limbs of the Olympic orocline, accommodated mainly by strike-slip faulting (Finley et al., 2019).

The west coast region of southern Wrangellia had experienced at least 40 million years of negligible cooling before Oligocene, as shown by its age, length, and modeling results (Figure 2.3). I attribute this phase to very slow erosion and tectonic quiescence, suggesting both the west and east sides of southern Wrangellia were covered by sedimentary strata in the Eocene, most likely the Cretaceous-Paleocene Nanaimo Group which currently crops out only along the east side of Vancouver Island.

Tectonic history incorporating our thermochronological data for southern Wrangellia is shown in Figure 2.7. Our data are consistent with southern Wrangellia being overlain by sedimentary rocks on both west and east sides before the subduction of Kula/Resurrection-Farallon ridge around 50 Ma (Figure 2.7(a)). At this time, Siletzia emerged as an oceanic plateau that underplated and heated overlying strata on the

west side, which subsequently deformed and metamorphosed to become the Pacific Rim terrane (Figure 2.7(b)) (Seyler et al., 2022; Geen and Canil, 2023). The younger component of the Pacific Rim terrane (Leech River Complex) was sedimentary rocks correlative with the Nanaimo Group to the east, as evidenced by detrital zircons (Seyler et al., 2022). Accretion of Siletzia to the Pacific Rim terrane along a paleo-plate interface, possibly the Leech River Fault, initiated the formation of Cowichan Fold and Thrust Belt and moderate-to-accelerated exhumation in the east. In contrast, the west coast region was not exhumed by this event (Figure 2.7(b,c)). With Cascadian subduction initiated, the shallow overlying sedimentary strata on the west side of Wrangellia was eventually eroded during moderate exhumation. The thicker Nanaimo Group strata on the east side was only partially removed in slow exhumation. The eroded strata might deposit in the Eocene-Oligocene Carmanah Group on the west margin (Figure 2.7(d)).

2.6 Conclusions

Thirteen new AFT central ages and sixteen AHe mean ages from the Wrangellia bedrock in southern Vancouver Island show mainly Paleocene to Oligocene cooling. The AFT length data show different degrees of track shortening of the samples, indicating a period of residence within partial annealing zone during exhumation. The thermal models of samples on the west region of the study area yielded negligible cooling (<0.5 °C/Myr) from at least 70 Ma and moderate cooling ($1.5\text{--}3$ °C/Myr) since ~ 30 Ma to the present. The samples on the central area mainly exhibit uniform slow cooling process ($0.5\text{--}1.5$ °C/Myr), whereas those close to the major faults of Cowichan Fold and Thrust Belt show accelerated cooling ($4\text{--}5$ °C/Myr) during the Eocene. The moderate-to-accelerated Eocene exhumation of this fold and thrust belt is related to

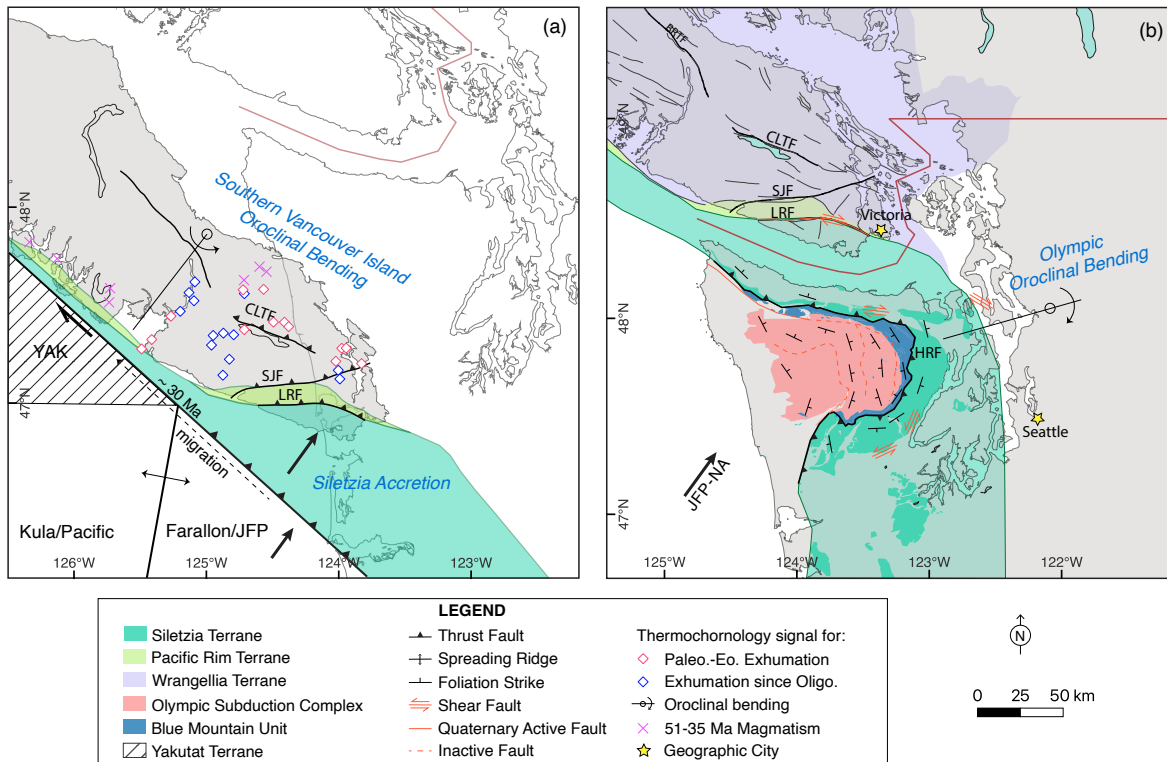


Figure 2.6: (A) Model for Siletzia accretion in the Eocene, oroclinal bending of southern Vancouver Island and Cascadian Subduction initiation. Cyan shape is the reconstructed Siletzia terrane along the boundary (modified from Miller et al. (2023)). The Kula-Farallon or Pacific-Juan de Fuca Ridge was migrating northward as the tail of Yakutat (YAK) along the boundary, and outboard of the study region around 30 Ma (Dobrovine and Tarduno, 2008; Miller et al., 2023). Magenta crosses show locations of near-trench magmatism in the Eocene. Red diamonds show the samples with exhumation signals for the Eocene southern Vancouver Island oroclinal bending Johnston and Acton (2003). Blue diamonds indicate Oligocene exhumation for the ridge migration and subduction initiation. (B) Model for Olympic orocline formation since early Miocene. The shape and location of Siletzia is similar to the modern setting (modified from Eddy et al. (2017)). Average orientations of foliation in Olympic Peninsula (black symbols) and locations of Quaternary-active and -inactive crustal faults (orange symbols) are modified from Finley et al. (2019). Thick black arrows show the plate motion direction. Stratigraphic unit and fault data are from Huntington et al. (1961); Massey et al. (2005); Cui et al. (2017). CLTF: Cowichan Lake Thrust fault, SJF: San Juan Fault, LRF: Leech River Fault, JFP: Juan de Fuca Plate, HRF: Hurricane Ridge Fault, BRTF: Beaufort Range Thrust Fault, NA: North America.

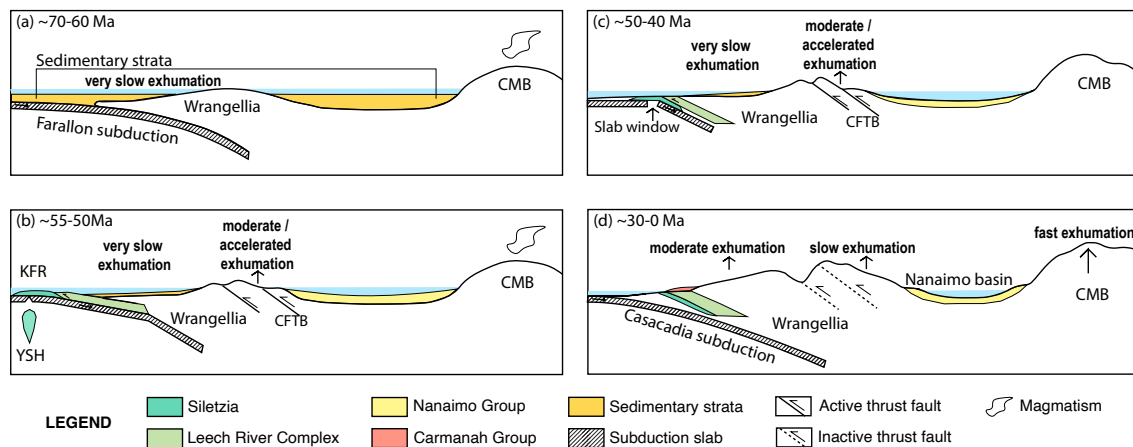


Figure 2.7: Schematic sketch (not to scale) of the tectonic development and the exhumation response around southern Wrangellia from ~ 70 to 0 Ma (modified after Seyler et al. (2022)). (A) Deposition of the sedimentary strata (Nanaimo Group) across southern Wrangellia, supported by the exhumation patterns of samples from the West Coast region. (B) Subduction of Kula/Resurrection-Farallon ridge (KFR) and passage of Yellowstone hotspot (YSH) caused formation of Siletzia as an oceanic plateau and subduction of part of the offshore sedimentary strata. Consequent oroclinal bending caused the formation of Cowichan Fold-and-Thrust Belt to the east and regional moderate-accelerated exhumation. The west coast and the east basin differed in extent of sedimentary burial. (C) The subducting strata were deformed to become meta-sedimentary rocks of the Leech River Complex to accommodate Siletzia accretion, with no change in exhumation pattern. (D) The accreted terranes were uncomfortably overlain by the Eocene-Oligocene Carmanah Group on the west coast. CMB—Coast Mountains Batholith.

oroclinal development caused by accretion of Siletzia. I propose that the offshore, west coast and east side of southern Wrangellia were all overlain by sedimentary strata before the Kula/Resurrection-Farallon ridge subduction around 50 Ma, after which the offshore part of overlying strata were underplated and became the Leech River Complex of the Pacific Rim Terrane. The shallow cover of sedimentary strata on the west coast was not removed until the exhumation at ~ 30 Ma, probably linked to Pacific-Farallon ridge migration and Cascadian subduction. I see no evidence in the AFT and AHe ages of this study for any exhumation driven by the translation of Yakutat, heating caused by slab window, near-trench magmatism or Miocene oroclinal bending to form the Olympic Mountains.

Chapter 3

Northern limit of initial Eocene Cascadia subduction revealed by varying exhumation patterns across Vancouver Island

3.1 Introduction

The modern Cascadia subduction zone is a major source of seismic hazards along western North America. This margin initiated during a major tectonic reorganization off the west coast of North America at 55–45 Ma, during which the unsubducted portion of the ancient Farallon Plate fragmented, giving birth to the Juan de Fuca Plate that subducts along today's margin (Figure 3.1). Plate-motion reconstructions for the past 80 Myr, based on seafloor magnetic anomalies, indicate that the Kula and Farallon oceanic plates subducted beneath the Alaska and Cascadia margins, respectively (Engebretson, 1985). However, the location and geometry of the ridge separating the two plates remain debated, as subduction has consumed nearly all pre-Oligocene magnetic anomalies. Early models suggested a single ridge subducting beneath the western North America (Engebretson, 1985) or Alaska (Bradley et al., 2003) based on seafloor magnetic isochrons, whereas more recent studies propose the coexistence of two spreading ridges bounding the intervening Resurrection Plate (Figure 3.1). Subduction of these ridges is thought to have generated two contemporaneous slab windows, producing distinct belts of near-trench magmatism along the margin (Haeussler et al., 2003; Madsen et al., 2006). The distribution of onshore magmatic records agree with the reconstructed positions and geometry of the subducted Kula and Farallon slabs from seismic tomography (Madsen et al., 2006) (Figure 3.1). A small detached slab is

interpreted as a thermally eroded remnant of the Resurrection plate, but is now located far north beneath Yukon between the Kula and Farallon slabs (Fuston and Wu, 2021). This leaves substantial uncertainty regarding both the existence and ultimate fate of the Resurrection Plate.

Plate reconstruction models place Vancouver Island by the trench on the leading edge of the overriding plate, near the proposed boundary between the Farallon and Kula/Resurrection Plates (Figure 3.1). To examine the timing and northern extent of the Eocene Cascadia margin, I constrain the exhumation history of Vancouver Island in the last 100 Myr using low-temperature thermochronology. The results reveal that the shift in exhumation pattern is linked to the onset of Cascadia subduction in the late Eocene, and the northern end of the island lay within a tectonic transition zone near the boundary between two oceanic plates that were converging toward North America during 50–40 Ma.

3.2 Geological Background

Subduction of the Kula and Farallon plates occurred along the Wrangellia margin before the Cenozoic. Plate boundary reorganization occurred 55–45 Ma at the Kula/Resurrection-Farallon ridge intersection, inducing near-trench magmatism along the margin and two oceanic plateaus straddling the ridge (Madsen et al., 2006; Wells et al., 2014). One Farallon fragment, Siletzia, accreted northward to the Pacific Rim then to the Wrangellia terrane along the San Juan and Leech River Faults, respectively, driving the oroclinal bending of southern Vancouver Island (Johnston and Acton, 2003). In contrast, Yakutat terrane, formerly part of the Kula Plate, translated northward to eventually converge with Alaska (Wells et al., 2014; Ten Brink et al., 2018). During this plate rearrangement, the modern Cascadia margin developed as the Juan de Fuca

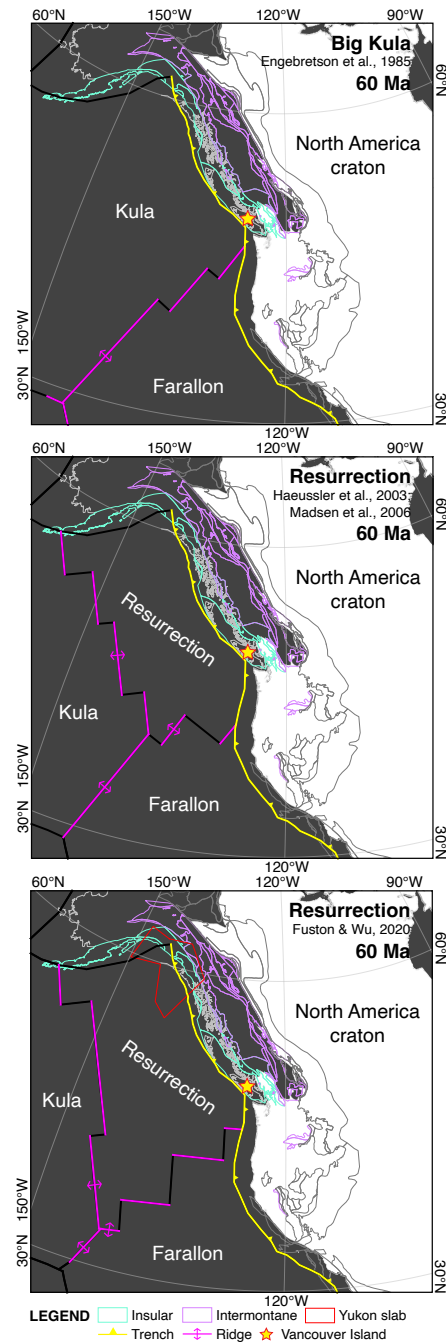


Figure 3.1: Plate models constraining the Kula/Resurrection-Farallon-North America triple junction location in the Paleocene. Plate reconstructions of the western terranes of North America are based on Fuston and Wu (2021) using GPlates. (A) triple junction south of Vancouver Island and a larger Kula plate (Engebretson, 1985). (B, C) triple junction south of Vancouver Island bounding the Resurrection plate, a Kula fragment. Different geometry and ridge-trench intersections are suggested based on varying data (Haeussler et al., 2003; Madsen et al., 2006; Fuston and Wu, 2021).

Plate (the remanent northern Farallon) began subducting.

Most previous studies place this ridge–trench intersection south of Vancouver Island during the Paleocene to Eocene (Figure 3.1) (Haeussler et al., 2003; Madsen et al., 2006; Fuston and Wu, 2021), although large uncertainties remain (Bradley et al., 2003). The Pacific-Juan de Fuca ridge has been located off Vancouver Island for at least 40 Myr, separating the Cascadia subduction margin to the south and the transcurrent Queen Charlotte margin to the north above a proposed slab window (Hyndman and Hamilton, 1993; Hyndman, 2015). The extent of the Cascadia subduction margin changed due to the geometry of the Juan de Fuca Plate and the propagation of the spreading ridge along its northern edge. Currently, northern Vancouver Island involves subduction of the Explorer microplate, broken off from the Juan de Fuca plate at ~ 4 Ma, and exhibits higher heat flow, more subdued topography and higher Bouguer gravity values compared to the southern regions (Audet et al., 2008).

3.3 Methods

3.3.1 Samples

Bedrock samples used in this study are from across Vancouver Island and mostly derive from igneous rocks of the Jurassic Bonanza arc (Figure 3.2). In the total of 20 samples (Table 3.1), 14 samples are granite to diorite of the Jurassic Bonanza arc of Wrangellia terrane (Canil et al., 2013) (10 samples from Island Plutonic Suite, 3 Westcoast Crystalline Complex, 1 Bonanza Volcanics). Two samples are from the post-accretionary near-trench plutons (Madsen, 2004), two from the Walker Creek intrusion in the Pacific Rim terrane, one from the Crescent terrane and one from the 5 Ma Klaskish pluton. The separation of apatite and zircon grains of the samples was carried out using standard magnetic and heavy liquid separation procedures. I determined three types of

low-temperature thermochronology ages: zircon U-He/Th (ZHe), apatite fission track (AFT) and apatite U-He/Th (AHe), with thermal sensitivities of around 140 to 220 °C (Reiners et al., 2004; Reiners, 2005; Guenthner et al., 2013), 60 to 120 °C (Wagner, 1968; Naeser and Faul, 1969) and 30 to 90 °C (Zeitler et al., 1987; Farley, 2000; Gautheron et al., 2009), respectively.

3.3.2 U-Th/He Dating

The ZHe and AHe analyses for most samples were performed at the Geo- and Thermochronology laboratory of the University of Calgary in Canada. Relatively euhedral, crack-free, inclusion-free and similar-sized grains were picked under a stereomicroscope. Normally, 3 zircon and 5 apatite grains are selected for a sample. The grains were characterized, and their dimensions were measured for alpha-ejection correction. Each grain was separately packed into a Nb tube for He extraction. Alphachron He extraction line was applied to measure He concentration. The parent nuclides were quantified by isotope dilution (U and Th) interfaced with an Agilent 7700 quadrupole inductively coupled plasma mass spectrometer (Q-ICP-MS). Durango apatite was used as a secondary mineral standard. More details of the standard lab procedures can be found in McKay et al. (2021). Two additional AHe ages are collected at the Institute of Geology China Earthquake Administration in Beijing, China, following the lab procedure described by Wang et al. (2017). Single-grain dates were calculated with the contents of ^4He , ^{238}U , ^{235}U , ^{232}Th and ^{147}Sm using the He ingrowth equation (Flowers et al., 2023b) and corrected with Ft factor (Table B.1 and B.3).

3.3.3 Fission Track Dating

AFT analysis was conducted at the University of Victoria, with the sample uranium content measured using the LA-ICP-MS. Apatite grains separated from a sample were

mounted in epoxy (mounting type A in Kohn et al. (2019)), attached to glass slide, and then polished in multiple steps. After polishing, sample mounts were etched in 5.5 mol/L HNO_3 for 20 s at a temperature of 21°C. Only 3 samples yielded enough confined tracks for length measurement. Some samples were irradiated with ^{252}Cf at the GeoSep Services Lab in Idaho, USA as an attempt to increase the number of measurable tracks. I used the Carl Zeiss Axio Imager M2m microscope equipped with iDS camera and TrackWorks software to capture stack images of fission track under 100× dry objective. Track densities and confined track lengths were determined from the captured images using the FastTracks software. I used the absolute laser ablation ICP-MS method for the measurement of parent isotope (Hasebe et al., 2004). The content of ^{238}U was measured using an Agilent 8800 ICP-MS operated in single quadrupole mode coupled to a Cetac LSX-213 G2+ Nd-YAG laser with Hel-Ex 2 sample cell laser ablation system. Considering most samples have small and partially broken grains, for the laser I used parameters of firing repetition rate of 6 Hz, 40s spot duration, 3.06 J/cm² fluence (or 15% laser output) and 20 μm spot diameter (20% laser output and 30 μm spot size for 160-02, -03). NIST611, NIST613 and NIST615 standard glasses were used as external standard calibration, and ^{43}Ca was used as an internal standard element. Most apatite varies in Ca contents from 36.7 to 40.6 wt%. I assume a stoichiometric Ca content of fluorapatite (39.5 wt%) for all samples (Mao et al., 2016). Madagascar and Durango standard apatite were included in the list of measurements as concentration references. Data reduction and calibration was performed on Iolite v4 (Paton et al., 2011; Paul et al., 2023). AFT single grain dates, central ages and the uncertainties were calculated using an absolute method implemented in IsoplotR (Table B.2) (Hasebe et al., 2004; Vermeesch, 2017, 2018).

3.3.4 Thermal Modelling

Thermal histories of samples were modelled using the inverse mode of QTQt software (Gallagher, 2012) (version 5.6.0). The modelling parameters, such as type of input data and general priors, are shown in Table B.4. This approach is based on the method of Bayesian transdimensional Markov Chain Monte Carlo (MCMC). I set up 50000 burn-in series to explore the model space and another 100000 post-burn-in iterations to approximate models that fit the specified priors on annealing or diffusion kinetics and time-temperature (t-T) constraints. The outcome is a set of acceptable thermal history models of which the acceptability is shown as a probability distribution. Compared to HeFTy software which uses a goodness-of-fit method and evaluates independent models, QTQt sequentially evaluates dependent models and naturally avoids over-complex models (Gallagher, 2012). I combined multiple data types (ZHe, AHe, FT count and length) for a sample in modelling. The radiation damage models of Gautheron et al. (2009) for apatite and Guenthner et al. (2013) for zircon were chosen as He diffusion kinetic priors. I used the model of Ketcham (2019) to calibrate the compositional effect on fission track annealing of apatite with Dpar data as the compositional proxy. The general prior encompassed the full range of measured dates and partial annealing and retention zones. Additional t-T constraints were incorporated based on the existing U-Pb and Ar-Ar ages from nearby samples within the same suite. Present-day temperature is assumed as $10\pm 10^{\circ}\text{C}$.

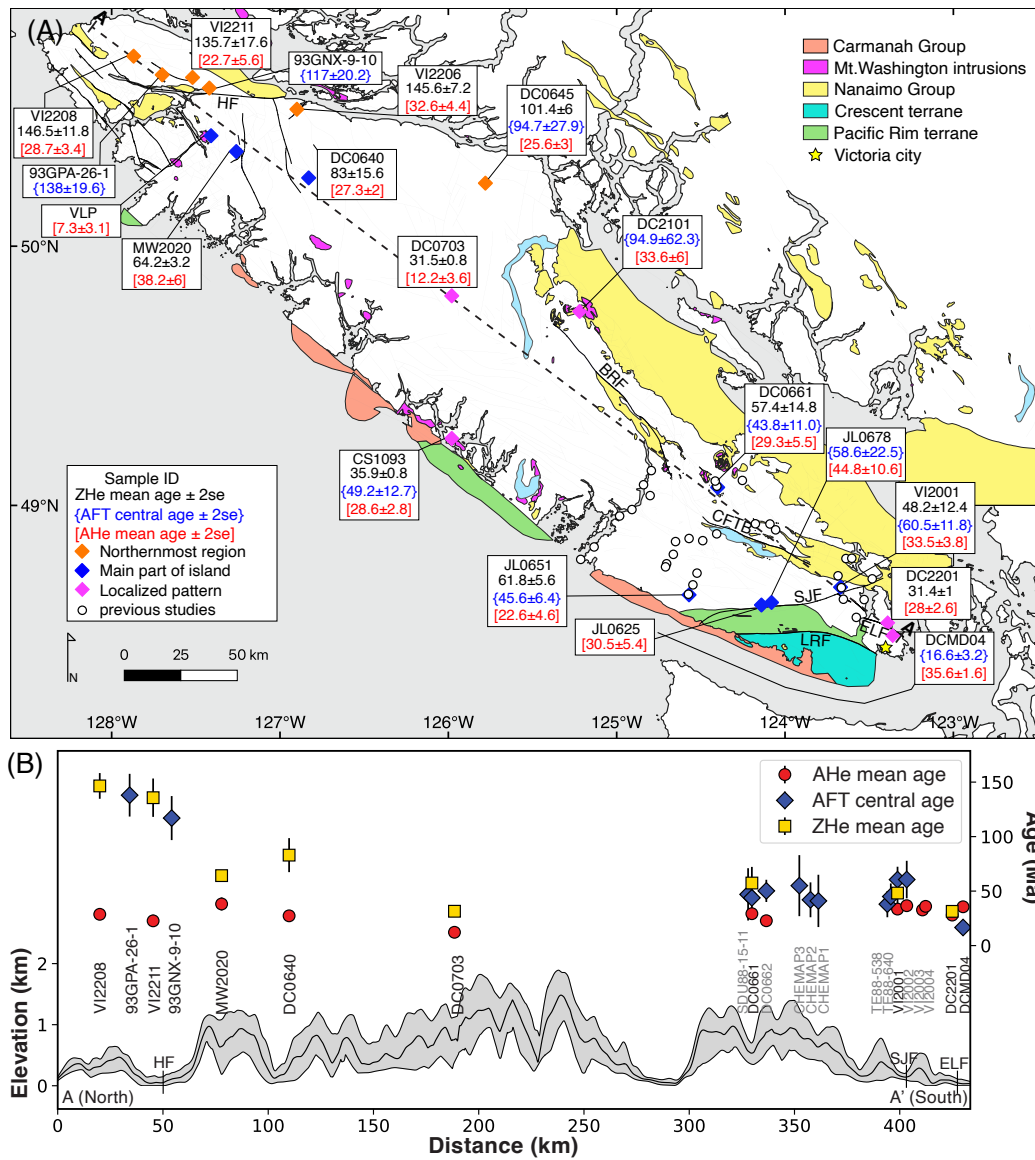


Figure 3.2: (A) Vancouver Island map, showing unfilled region of Wrangellia terrane, accreted by Pacific Rim and Crescent terranes, and faults marked by lines. The diamond and the circle symbols mark the sample locations in this study and from previous work, respectively (Currie and Grist, 1996; England et al., 1997; Qiao et al., 2024). Diamonds in different colors indicate major types of cooling patterns in thermal models. ZHe mean ages, AFT central ages and AHe mean ages with 2 standard error are labeled in black, blue and red. (B) Swath profile along the long axis of Vancouver Island. The swath is 10 km wide, and the mean elevation is shown by a black line within the gray envelope of maximum and minimum elevations. Red circles, blue diamonds and yellow squares with bars indicate location of the samples nearby and ages with 2se error. The location of the swath (AA') is shown as the dashed black line in [A]. The short vertical lines marked the location of the faults across the profile. HF: Holberg Fault, BRF: Beaufort Range Fault, CFTB: Cowichan Fault and Thrust Belt, SJF: San Juan Fault, LRF: Leech River Fault, ELF: Elk Lake Fault.

Table 3.1: Summary of sample information, ages and uncertainties

Field ID	Lab ID	Long (°)	Lat (°)	Elev. (m)	Terrane	Suite ^a	Lithology	ZHe grain No. ^b	ZHe Mean (Ma) ^c	ZHe 1se (Ma) ^c	AHe grain No. ^b	AHe Mean (Ma) ^c	AHe 1se (Ma) ^c	AFT grain No. (Ns) ^e	AFT Central (Ma) ^f	AFT 1se (Ma) ^d	Track No. ^g	MTL (μm) ^h	MTL 1sd (μm) ⁱ
VI2208	160-1	-127.87	50.72	226	Wrangellia	IPS	diorite	3	146.5	5.9	5	28.7	1.7	17 (221)			22(cf)	12.1	2.2
VI2211	160-2	-127.52	50.64	91	Wrangellia	IPS	diorite	2	135.7	8.8	5	22.7	2.8	4 (19)					
VI2206	160-3	-126.90	50.52	164	Wrangellia	IPS	diorite	3	145.6	3.6	5	32.6	2.2	4 (43)					
DC0640	160-4	-126.83	50.26	153	Wrangellia	IPS	granodiorite	3	83.0	7.8	5	27.3	1.0						
DC0645	160-5	-125.78	50.24	52	Wrangellia	IPS	granodiorite	3	101.4	3.0	5	25.6	1.5	33 (419)	94.7	14.0	102	12.0	1.5
DC0703	160-6	-125.98	49.81	281	Wrangellia	WCC	granodiorite	3	31.5	0.4	5	12.2	1.8						
DC2101	160-7	-125.22	49.75	648	Wrangellia	Mt.W	qz diorite	3	35.9	0.4	5	33.6	3.0	26 (79)	94.9	31.2	5	15.3	1.1
CS1093	160-8	-125.98	49.26	0	Wrangellia	Catface	qz diorite	3	28.6	1.4	5	28.6	1.4	32 (393)	49.2	6.4	102	13.0	1.8
JL0678	160-9	-124.08	48.62	872	Wrangellia	BONV	basaltic andesite	5	44.8	5.3	5	44.8	5.3	31 (111)	58.6	11.3	15(cf)	14.0	1.4
JL0625	160-10	-124.14	48.61	755	Wrangellia	WCC	granodiorite	5	30.5	2.7									
AG044*	160-12	-123.94	48.51	439	Pacific Rim	WCI	metatonalite	3	122.3	6.5	5	35.6	0.8	33 (812)	16.6	1.6	109	13.7	1.2
DCMD04	160-13	-123.36	48.49	45	Wrangellia	WCC	diorite												
DC2201	160-14	-123.39	48.54	83	Wrangellia	IPS	granodiorite	3	31.4	0.5	4	28.0	1.3				5	14.1	1.5
VI2200*	160-15	-123.75	48.38	96	Crescent	Crescent	tonalite	3						7 (60)			13	12.3	1.7
MW2020	160-17	-127.26	50.36	878	Wrangellia	IPS	granitoid	4	64.2	1.6	5	38.2	3.0						
DC0661	160-18	-124.40	49.07	336	Wrangellia	IPS	granodiorite	5	57.4	7.4	4	29.3	2.8	21 (240)	43.8	5.5	98(cf)	12.0	1.8
JL06-51	160-19	-124.57	48.65	246	Wrangellia	IPS	granite	3	61.8	2.8	8	22.6	2.3	30 (272)	45.6	3.2	95(cf)	10.7	1.7
AG114*	160-20	-123.95	48.51	483	Pacific Rim	WCI	metatonalite	3	18.7	25.9									
VI2001	160-21	-123.67	48.68	94	Wrangellia	IPS	diorite	5	48.2	6.2	5	33.5	1.9	27 (105)	60.5	5.9	93(cf)	12.7	1.7
VLP		-127.41	50.42	131	Wrangellia	Claskish	granitoid	5	7.3	1.5									

Note: Samples are stored in the collections of the University of Victoria, School of Earth and Ocean Sciences, Victoria, BC V8W 2Y2, Canada.

^aSuite: Name of stratigraphic unit sampled. IPS - Island Plutonic Suite. WCC - West Coast Complex. BONV - Bonanza Volcanics. Mt.W - Mt Washington.

^bNumber of ZHe or AHe grains analysed.

^cArithmetic mean age of corrected ZHe or AHe grain dates.

^d1σ standard error for ZHe, AFT or AHe mean sample ages.

^eThe grain number of AFT samples collected. (Ns) means the total number of spontaneous tracks measured for the sample.

^fAFT central age calculated in radial plots.

^gThe number of confined track lengths for AFT samples. (cf) means the track length data are collected after Cf irradiation.

^hMTL: Mean confid fission track length.

ⁱ1σ standard deviation for MTL data.

*These samples do not produce useful sample ages.

3.4 Results

3.4.1 Zircon (U-Th)/He

Our entire dataset is given in Table B.1 in the Appendix. I calculated geometric mean sample ages with 1σ standard error for 13 samples which range from 31.4 ± 0.5 Ma to 146.5 ± 5.9 Ma (Table 3.1, Figure 3.2). The single-grain dates of all samples have a acceptable reproducibility of $\leq 15\%$ (Table B.1). Plots of the intra-sample analysis by Incaplot (Härtel et al., 2022a; Härtel, 2023) in the Supplemental Material (Figure B.1 to B.3) show a good fit between regressive isochron age and pooled age in He-eU plots (Figure B.2) and uniform ZHe dates across a span of eU (effective uranium concentration) (Figure B.3), indicating non-significant grain-size influence and radiation-damage-independent He retention. A few samples with larger date dispersion (MW2020, VI2001) show a larger offset between isochron and pooled ages. Sample DC0661 shows a negative date-eU correlation (Figure B.3), suggesting a possible effect of high radiation damage on ZHe dates. All samples except VI2208 exhibit a narrow range of equivalent spherical radius (R_s) of $30\text{--}70\text{ }\mu\text{m}$ and display a non-linear date- R_s correlation (Figure B.1), implying minimal size-related effect on the dates. The He-eU plots of all ZHe data (Figure B.1) generally reveal two distinct regressive trends and two groups of ZHe ages, one of early Cretaceous, the other of Eocene to Oligocene. I performed Ft correction and used the radiation damage model of Guenthner et al. (2013) to reduce the minor influence of grain sizes and radiation damage on the apparent ages.

3.4.2 Apatite Fission Track

Fission tracks were counted, and U concentrations were measured for 9 samples (Table B.2). Only 5 samples contained enough grains with measurable U content to determine sample ages. The AFT ages range from 16.6 ± 1.6 Ma to 94.9 ± 31.2 Ma (1σ standard error) (Table 3.1 and Figure 3.2). Due to low apatite yield and breaking of crystals during laser ablation, samples VI2208, VI2211 and VI2206 contained only between 4 to 17 datable grains. The AFT data of these samples were considered with caution and not used in thermal modelling. The radial plots of the 5 samples on IsoplotR (Figure B.4) show that 2 samples have a p-value within 0.05-0.95 and MSWD (Mean Squared Weighted Deviation) around 1, indicating a fast cooling process. Three samples (DC0645, DC2101, CS1093) failed the chi-square test (p-value lower than 0.05, MSWD of around 1.5–2.0), displaying a degree of overdispersion. These samples show a continuous age distribution with dispersion of 21 to 57%, indicating more protracted residence within the partial annealing zone or random effects in the presence of compositional complexity (Kohn et al., 2024).

Mean confined track lengths of all samples yield between 12.0-15.3 μm (Table 3.1). From three samples I obtained sufficient (>90) measurements for modeling the length distributions. Applying ^{252}Cf irradiation (at the GeoSep Services Lab in Idaho, USA) to increase the number of measurable tracks did not yield more samples with track length data for thermal history modeling. The length data of the three samples (Figure B.5) show slightly left-skewed unimodal distribution with mean track lengths (MTL) of 12.0–13.7 μm and standard deviations (SD) of 1.2–1.8 μm . The length data suggest that the samples mostly experienced a monotonous cooling process through the partial annealing zone (PAZ) without reheating. Some samples with long MTL over 13.5 μm may have experienced quick cooling (DC2101, JL0678, DCMD04, DC2201), whereas others experienced minor annealing and longer residence within the PAZ (VI2208,

DC0645).

3.4.3 Apatite (U-Th)/He

I obtained 70 AHe single grain dates for 14 samples and reported their geometric mean ages with 1σ standard error for a sample (Table 3.1). As shown in Table B.3, a few outliers of grain dates (abnormally old or young) are excluded from the mean age calculation. By doing this, the reproducibility of AHe ages is $\leq 15\%$. The corrected single grain dates range from 4 Ma to 65 Ma, and the sample ages range from 7.3 ± 1.5 Ma to 44.8 ± 5.3 Ma (Figure 3.2). There is no clear correlation between the AHe age and R_s (Figure B.1), suggesting limited grain size effect on He retentivity. Most individual samples show a scattered age-eU pattern, and a good fit with a small systematic offset between regressed isochron age and pooled age in the He-eU plots (Figure B.6 to B.7), implying a minor radiation-damage effect on He diffusion and small date dispersion. Two samples (VI2211 and DC0640) show incongruous isochron ages and pooled ages due to an outlier, which was excluded from the mean age calculation. The AHe mean sample ages across Vancouver Island vary in a narrow range from the Oligocene to the early Miocene. I applied the Ft correction and radiation damage model of Gautheron et al. (2009) to the thermal models to improve data reliability.

3.5 Thermal History Models

I modelled numerical thermal histories for 15 samples in this study and 2 samples from northern Vancouver Island from the study of Currie and Grist (2024). Each of the 17 samples contains at least two types of data from ZHe, AFT count, AFT length and AHe. The detailed parameters used for modelling are provided in Table B.4. The original outputs of time-Temperature (t-T) plots are shown in Figure B.8, and

those assuming sphere geometry and no-reheating are shown in Figure 3.3 and B.8. These two model versions have the same t-T trends. Sphere geometry and conditions of no-reheating were applied to enhance visualization and eliminate the geologically insignificant recent rapid-cooling pattern in a few samples. I use the following terms to describe cooling at different rate ranges: ‘very slow’ or ‘quiescent’ cooling of <1 °C/Myr; ‘slow’ for $1-2$ °C/Myr; ‘moderate’ for $2-5$ °C/Myr; ‘fast’ for $5-10$ °C/Myr; ‘rapid’ for >10 °C/Myr. Thermal models of the samples show a varying north-south spatial pattern:

3.5.1 Northernmost Island

Four samples in this study and two samples of Currie and Grist (2024) from the northern end of Vancouver Island show a long residence (cooling ≤ 0.5 °C/Myr) at 2–4 km depth for over 70 Myr after rapid cooling >10 °C/Myr in the early Cretaceous, followed by an onset of exhumation to surface at 45–35 Ma at a cooling rate of around 1.5 °C/Myr (Figure 3.3 (A)). This pattern is common along and north of the Holberg fault, the same region of Vancouver Island showing higher heat flow and low topography (Lewis et al., 1991). One sample (DC0703) from the central island shows a similar trend but with higher cooling rates of 1 °C/Myr followed by 4.3 °C/Myr.

3.5.2 Main part of Island

A second type of pattern shown in five samples from across Wrangellia and at least three samples from the last chapter exhibits fast cooling of $4.5-6.5$ °C/Myr followed by a slow phase of $1-2.5$ °C/Myr since ~ 50 Ma (Figure 3.3 (A)). A few samples (DC0640, MW2020) close to the northern region show a decrease of cooling since 75–40 Ma. This is a common exhumation pattern of the majority of Vancouver Island.

The western part of southern Vancouver Island shows fast cooling of $5.5-6.5$ °C/Myr

followed by quiescent cooling (<0.5 °C/Myr) for over 30 Myr in Eocene, changing to a moderate rate of $1.5\text{--}2.5$ °C/Myr since 35–25 Ma. This pattern was also noted by Qiao et al. (2024) and exemplified by sample JL06-51 in this study (Figure B.8).

3.5.3 Localized Patterns

Two samples from the post-accretionary Mt. Washington Suite Eocene plutons show rapid cooling >10 °C/Myr around 45 Ma followed by slow cooling of $1\text{--}2$ °C/Myr to the surface, which correlates with rapid intrusion and cooling in the shallow crust (Figure B.8).

Two other samples from Saanich Peninsula on the southeastern end of Vancouver Island show rapid cooling (>10 °C/Myr) during 30-20 Ma through PAZ and PRZ followed by slow cooling of ~ 1 °C/Myr since the Miocene (Figure B.8).

3.6 Discussion

Since ~ 40 Ma, similar cooling rates of $1\text{--}2.5$ °C/Myr are observed across all of Vancouver Island in thermal history models in this and previous work (Qiao et al., 2024). Such rates are attributed to exhumation at a steady rate ($\sim 0.05\text{--}0.13$ mm/yr assuming a geothermal gradient of $20\text{--}25$ °C/km) in the overriding plate of a subduction margin. I attribute this magnitude of exhumation to convergence from a stable Cascadia subduction setting along all of Vancouver Island (Figure 3.3 (B)).

Prior to 50 Ma, however, the majority of Vancouver Island experienced fast exhumation ($\sim 0.18\text{--}0.35$ mm/yr). I suggest that decreasing exhumation rate after 50 Ma for the main part of island corresponds to the change in convergence vector from Farallon to Cascadia subduction. Around 50 Ma, the arrival of the buoyant Siletzia plateau at the margin disrupted the subduction by jamming the trench and may have

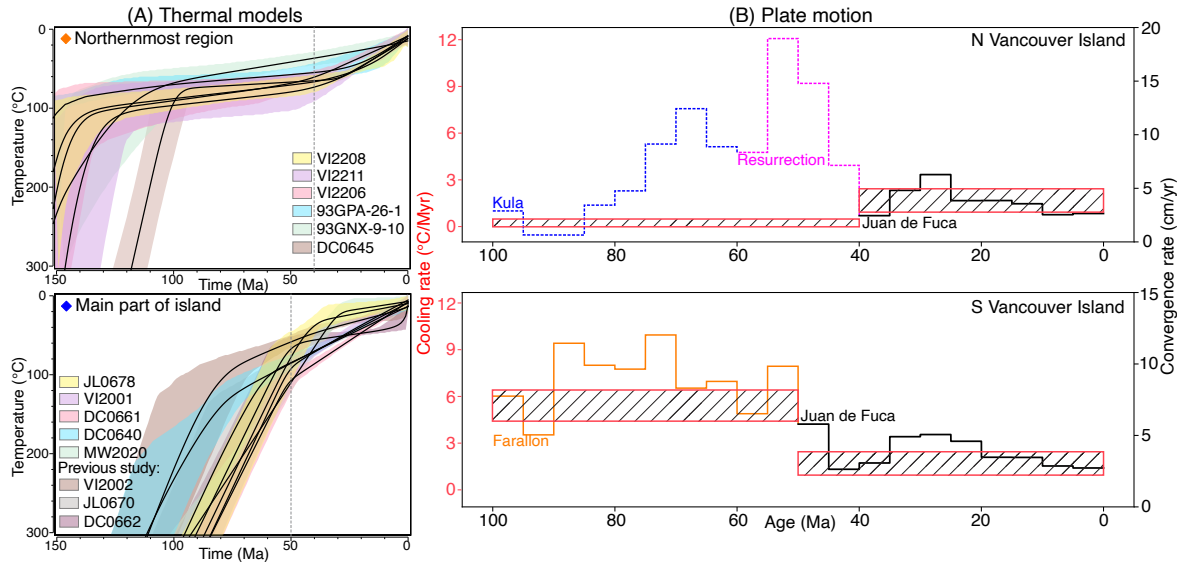


Figure 3.3: (A) Spatial patterns of thermal models by QTQt revealed by samples in this and previous studies (Qiao et al., 2024). The black line for each sample is an expected model, a mean value weighted by the posterior probability. The colored envelope indicates 95% probability interval. The dashed lines indicate changing time of cooling rates. Models of other outliers are in supplemental material. (B) Convergence history since 100 Ma for northernmost and southern Vancouver Island based on plate motion model of Fuston and Wu (2021) assuming a spreading ridge beneath the northern island. Change of convergence rate (averaged every 5 Myr) is shown in different colors indicating the different converging oceanic plates. Change of cooling rate (red scale) determined in this study is shown in red boxes filled with pattern.

facilitated the formation of the Juan de Fuca Plate as a northern fragment broken off from the Farallon plate, thereby initiating Cascadia subduction (Madsen et al., 2006; McCrory and Wilson, 2013; Wells et al., 2014). These changes were accompanied by changes in plate motion vectors (Clennett et al., 2020; Fuston and Wu, 2021), reducing convergence rates and potentially weakening plate coupling, which in turn led to a marked decrease in the exhumation rate of the overriding plate. This is supported by the reconstructed plate motion history since 100 Ma using GPlate-based model of Fuston and Wu (2021), assuming a shift from Farallon to Cascadia subduction since ~ 50 Ma for the location of southern Vancouver Island (Figure 3.3 (B)). The convergence transition at ~ 50 Ma is recorded by thermochronology as clear decrease in the cooling rates of the Wrangelia terrane.

The exhumation pattern differs in the far north of Vancouver Island, with minimal exhumation (< 0.05 mm/yr) for over 70 Myr before 40 Ma, reflecting a long-term tectonic quiescence. Uplift and exhumation of an accretionary wedge is most likely driven by strain transferred from the subduction interface to the overriding plate. During 50–40 Ma, despite the established Cascadia margin, persistently low cooling and exhumation rates offshore of the northernmost region reveal a separate tectonic domain. I infer that the rocks currently underlying the northernmost Vancouver Island were situated along Kula or Resurrection margin, while its southern boundary with Farallon likely remained beneath the island until ~ 40 Ma when the ridge shifted northward (Figure 3.4). The ridge migration is concurrent with the predicted complete subduction of the Resurrection plate, Pacific capture of the Kula plate and the initiation of Queen Charlotte transform margin (Lonsdale, 1988; Hyndman and Hamilton, 1993; Madsen et al., 2006; Fuston and Wu, 2021).

Our inference for the oceanic plate configurations is consistent with previous 'Big Kula' model or the 'Resurrection' model for the western North America (Engebretson,

1985; Haeussler et al., 2003). In addition, our thermal history models reveals the Kula/Resurrection plate probably moved primarily parallel to the margin before 40 Ma (Figure 3.4). Minimal exhumation of the continental margin is expected under reduced convergence and crustal shortening due to transform motion or oblique convergence of a young buoyant oceanic plate along the boundary. Such a setting is supported by the plate circuit reconstructions of a primarily northward Kula/Resurrection motion along the North America margins during Late Cretaceous to middle Eocene (Engelbreton, 1985; Doubrovine and Tarduno, 2008), and a more northward strike of pre-Eocene Vancouver Island revealed by $33^\circ \pm 25^\circ$ counterclockwise rotation of Wrangellia terrane relative to North America in the paleomagnetic data (Irving and Yole, 1987; Stamatakis et al., 2001; Prothero et al., 2008). This predicted Kula/Resurrection motion provides another explanation for the limited tomographic detection of a subducted Resurrection slab beneath Yukon, and its absence farther south beneath western North America if assuming a convergent motion (Fuston and Wu, 2021). A modern analogue for the Eocene tectonic setting offshore Vancouver Island could probably be the northern boundary of the Juan de Fuca plate. Fragmentation of the Juan de Fuca near its northern ridge (Explorer plate) may have resembled the Farallon breakup at ~ 50 Ma, while the shift from Juan de Fuca subduction to Pacific motion along the Queen-Charlotte transform margin mirrors the transition from Farallon subduction to coast-parallel translation of Kula/Resurrection before ~ 40 Ma.

3.7 Conclusions

Analysis of exhumation history of Vancouver Island provides new insights into the northern boundary of the Eocene Cascadia subduction zone and Cenozoic plate motion of two distinct oceanic plates offshore Vancouver Island. The AHe ages (22–45 Ma)

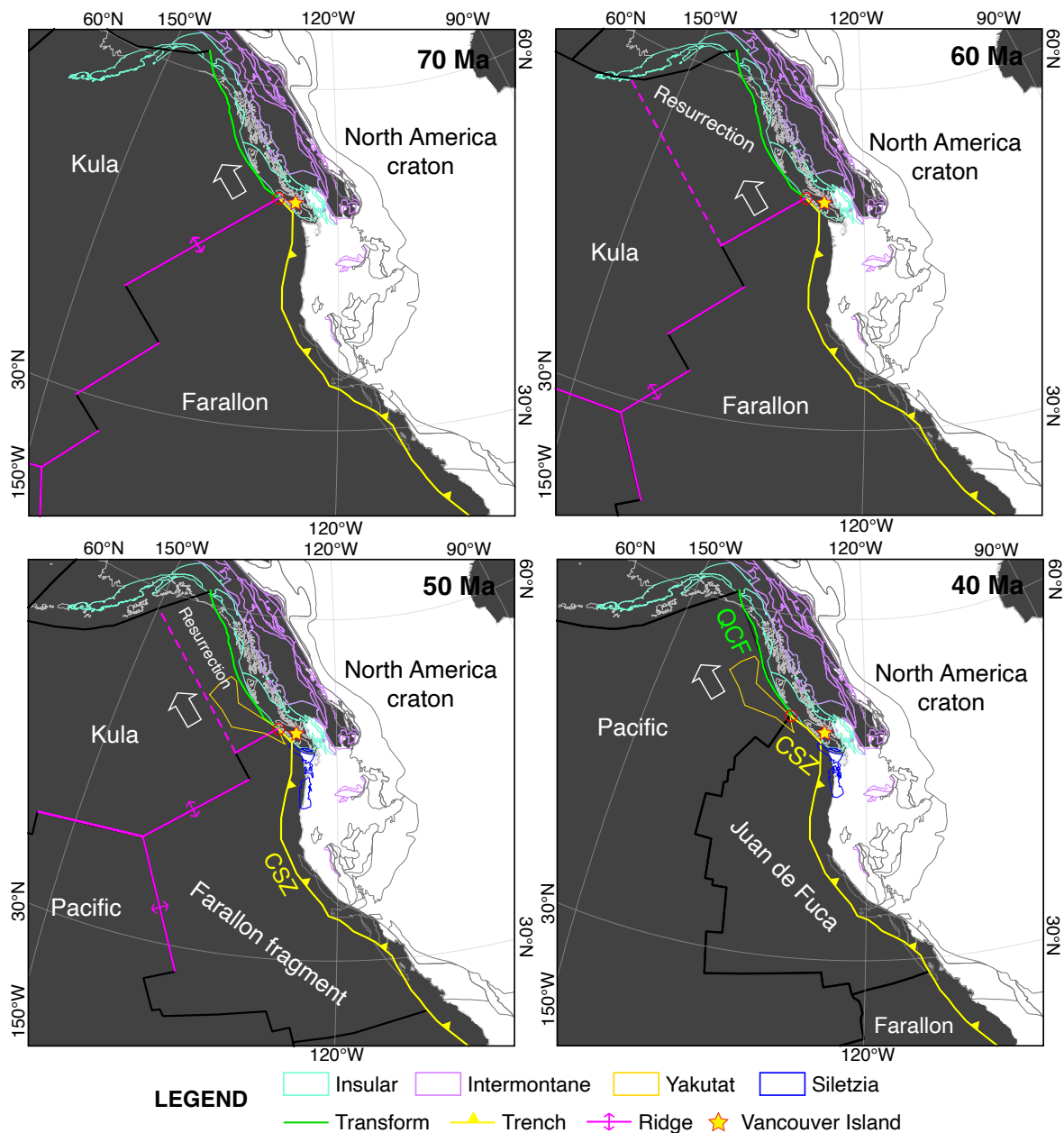


Figure 3.4: Reconstructed oceanic plate evolution of the study region between 70–40 Ma relative to fixed North America plate using GPlates, modified from the model of Fuston and Wu (2021). The yellow star shows the location of Vancouver Island. Note that Farallon plate has fragmented since 50 Ma and the Kula was captured by Pacific plate since 40 Ma. The locations of the Kula/Resurrection-Farallon ridge at trench (red circle) between 70–40 Ma are modified based on the hypothesis of this study, and the white arrow shows a suggested plate motion. QCF: Queen Charlotte Fault, CSZ: Cascadian Subduction Zone.

are consistent across the island, whereas the ZHe and AFT ages display a spatial trend, exceeding 100 Ma in the north end and dropping below 70 Ma in the south. Thermal models likewise indicate quiescent cooling in the northernmost region until ~ 40 Ma, and fast cooling in the majority of the island until ~ 50 Ma, followed by a slow phase throughout the island. The exhumation contrast reflects two pre-Eocene tectonic regimes: Kula/Resurrection transform margin with northward motion along northernmost Vancouver Island, while the ancient Farallon plate subducted beneath the main part of the island. Convergence rates decreased with the initiation of the Cascadia subduction zone at ~ 50 Ma, which replaced Farallon subduction and led to lower exhumation rates across most of Vancouver Island. The northern limit of Eocene Cascadia margin was thus situated around the northern island, shifting north after 40 Ma as the northernmost region was captured and exhumed with the rest of the island.

Chapter 4

Testing the zircon Raman dating method on igneous rocks with varied cooling histories

4.1 Introduction

Zircon Raman dating is an emerging technique in thermochronology that estimates thermal histories from measured radiation damage in zircon minerals. The method quantifies the accumulated damage from mainly alpha decay of U and Th in the lattice, gradually lost during thermal annealing in a rock's thermal evolution through the crust (Pidgeon et al., 1998; Nasdala et al., 2001, 2002). The determination of radiation damage densities was first suggested by Holland and Gottfried (1955) using X-ray diffraction, but its microscale measurement was made possible by Raman spectroscopy (Pidgeon et al., 1998; Nasdala et al., 2001, 2002). A systematic analytical protocol for zircon Raman dating was not established until recent years (Pidgeon, 2014; Anderson et al., 2020; Härtel et al., 2021a,b, 2022b). However, the method's utility for interpreting natural samples remains an open avenue for investigation, particularly its ability to record distinct cooling paths.

Thermochronological data from the previous studies and earlier chapters of this thesis provide essential constraints on the Cenozoic thermal histories of crustal rocks from Vancouver Island, associated with the tectonic evolution around the ridge-trench intersection of Kula/Resurrection-Farallon-North America. These results yield a range of thermal history patterns in a relatively simple tectonic setting, offering an ideal framework for evaluating zircon Raman dating method as a low- to mid-temperature thermochronometer within a 260–370 °C closure interval. This chapter presents the first application of this new method to intrusive rocks from Vancouver Island. By

analyzing samples with distinct and well-constrained thermal histories, including rapid, multi-stage, and prolonged slow cooling, I assess the sensitivity of zircon Raman ages to different cooling processes and the method’s applicability in a subduction zone forearc setting. This work will refine our understanding of the low- to mid-temperature thermal evolution of Vancouver Island, and provides a field-based reference for applying zircon Raman dating in other convergent margin settings.

4.2 Background

4.2.1 Geology Background

Vancouver Island is composed of the Wrangellia, Pacific Rim and Crescent terranes. All of samples in this study are from Wrangellia (Figure 4.1), built upon by the Jurassic Bonanza arc during 205–165 Ma, including the Westcoast Crystalline Complex, the Island Plutonic Suite, and the Bonanza Volcanic Group (Canil et al., 2010, 2013; Canil and Morris, 2024). Vancouver Island was then overlain by sediments of the Late Cretaceous Queen Charlotte Group in the north and by the Late Cretaceous to Paleogene Nanaimo Group throughout the island (Coutts et al., 2020; Sproule, 2024). Since the late Cretaceous, the island started to show differing crustal deformation and exhumation patterns in response to tectonic evolution along the continental margins. The southern island shows thermochronological records of oroclinal bending, Eocene sedimentation and subduction initiation of the Juan de Fuca plate (Currie and Grist, 1996; England et al., 1997; Currie and Grist, 2024; Qiao et al., 2024). Differential exhumation between the northernmost sector and the remainder of the island revealed in the previous chapter constrains the history of ridge-trench interaction at 50–40 Ma and defines the paleo-boundary of the nascent Cascadia margin. During this period, the Pacific Rim and Crescent terranes accreted to Wrangellia along the Leech River and

San Juan Faults, respectively, subsequently followed by post-accretionary intrusions of the Mt. Washington and Catface suites during 41–35 Ma (Figure 4.1). After ~ 40 Ma, the ridge–trench intersection migrated north of Vancouver Island, while the area to the south has been subducted within the modern Cascadia subduction zone.

4.2.2 Samples

I constrained zircon Raman ages for eight intrusive rock samples from Vancouver Island in Canada and one volcanic rock sample from the Flöha Basin ignimbrites in Germany for instrument calibration. In the eight intrusive rock samples, six samples are from the Island Plutonic Suite of the Jurassic Bonanza arc; two samples are from the Eocene Mt. Washington and Catface plutons. The samples were selected to reflect a range of varying thermal histories, constrained on the basis of the ZHe, AFT and AHe data in previous chapters. Samples VI2208 and VI2206 were intruded in northern Vancouver Island during 190–170 Ma, then experienced a long residency at 2–4 km depth for over 100 Myr before slow exhumation to the surface since ~ 40 Ma. Samples DC0661 and VI2001 from southern Vancouver Island have similar emplacement ages, but experienced fast followed by slow exhumation to the surface since at least 80 Ma. Samples CS1093 and DC2101 are from plutons that cooled rapidly at depths of 2–4 km in the Eocene, then progressively exhumed to the surface. Samples DC1002 and CS10109 are samples of Jurassic intrusive rocks intruded at 184–186 Ma and are the country rock adjacent to younger Eocene plutons with emplacement ages of 41 Ma. They were selected to test whether the subsequent Eocene thermal event may have reset the thermal histories as recorded by the zircon Raman method.

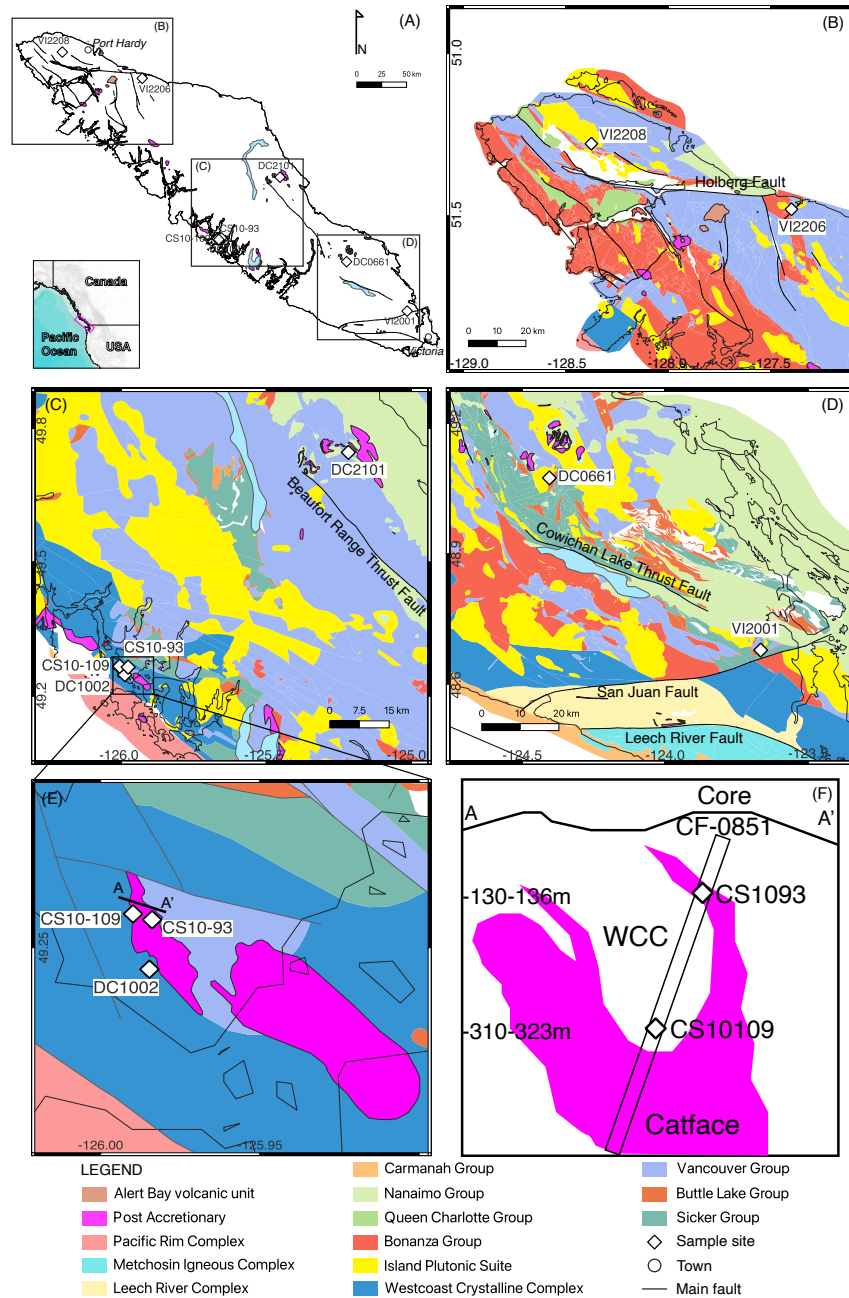


Figure 4.1: (A) Map of Vancouver Island and sample sites in this work. Detailed geological units for the region, each comprising different sample types, are presented in the three subplots: (B) northern region with quiescent cooling samples, (C) central region with Eocene plutonic and adjacent samples, and (D) southern region with multi-stage cooling samples. (E,F) detailed map and cross-sectional diagram (not-to-scale) showing relative locations of the drill core samples at depths. The diamonds mark the sample locations, and faults are marked by lines. WCC: Westcoast Crystalline Complex.

4.3 Zircon Raman Dating

4.3.1 Principles

During the radioactive decay of ^{238}U , ^{235}U and ^{232}Th in zircon, atomic displacement and disorder in the crystal lattice are produced mainly by the emission of α -particles and recoil of the heavy daughter nucleus (Nasdala et al., 2001). In the absence of annealing, radiation damage gradually accumulates within the crystal lattice, transforming it from a crystalline to a metamict state (Nasdala et al., 2001; Härtel et al., 2022b, 2024). With increasing temperature, radiation damage in a zircon undergoes approximately three stages of annealing: anisotropic defect annealing along mainly the a axis at low temperature, long-range order recovery over 730 °C, and eventually restoring to the fully ordered crystalline structure (Geisler et al., 2001; Geisler, 2002).

The present degree of radiation damage in a zircon crystal depends on its U and Th concentrations, the age, and the thermal history (Anderson et al., 2020). Raman spectroscopy offers a non-destructive and high-resolution way of measuring radiation damage. The accumulated damage or damage density is typically expressed as the cumulative number of α -decay events since zircon formation, referred to as α -dose ($D\alpha$) in units of α/g . As $D\alpha$ increase, Raman bandwidths (FWHM: full width at half-maximum, $\Gamma[\text{cm}^{-1}]$) increase, and band positions ($\omega[\text{cm}^{-1}]$) shift to lower frequencies (Figure 4.2) (Pidgeon et al., 1998; Nasdala et al., 2001). In a fully ordered zircon, the Raman shifts (ω) at vibrational modes of $\nu_1(\text{SiO}_4)$, $\nu_2(\text{SiO}_4)$, $\nu_3(\text{SiO}_4)$ bands, and external rotation (ER) bands occur around 975, 439, 1008 and 357 cm^{-1} , respectively (Anderson et al., 2020). Linear relationships between the FWHM of these four bands and the α -dose were calibrated for unannealed zircons (Nasdala et al., 2001; Anderson et al., 2020; Härtel et al., 2021a):

$$\Gamma_{\alpha}(\text{cm}^{-1}) = \Gamma_0(\text{cm}^{-1}) + \frac{\Delta\Gamma}{\Delta D} \left(\frac{\text{cm}^{-1}}{\alpha/\text{g}} \right) D_{\alpha}(\alpha/\text{g}), \quad (4.1)$$

where the regression parameters were calibrated for Γ_0 the FWHM of an undamaged zircon, and $\Delta\Gamma/\Delta D$ the dose response (Härtel et al., 2021a).

Combining Raman spectroscopy with in-situ measurements of parent U and Th concentrations, expressed as an effective uranium concentration (eU), enables the calculation of zircon Raman ages. The U and Th contents can be determined using various analytical techniques, such as LA-ICP-MS, SIMS and EPMA. For ages ranging from 1 Ma to 1 Ga, eU values are used to recalculate elemental actinide concentrations based on the decay constant of ^{238}U (Härtel et al., 2021a):

$$eU(\mu\text{g/g}) = (1.04 \rightarrow 1.06)[U] + (0.25 \rightarrow 0.23)[Th] \quad (4.2)$$

The apparent zircon Raman age (t) is based on a single-parent equation:

$$t(\text{yr}) \approx \frac{1}{\lambda_{238}} \ln \left(1 + \frac{M_{238}}{8N_A} \frac{D_{\alpha}(\alpha/\text{g})}{eU(\mu\text{g/g})} \right) \quad (4.3)$$

where λ_{238} is the decay constant of ^{238}U ($1.55 \cdot 10^{-10}$), M_{238} is the molar mass (238.05 g/mol), and N_A is Avogadro's number ($6.022 \cdot 10^{23} \text{ mol}^{-1}$).

As such, a true zircon Raman age can be obtained by this equation only under ideal conditions when a sample cooled rapidly to a temperature below the annealing threshold. The thermal evolution of a sample dictates the geological significance of its apparent age. Typical closure temperatures (T_c) for zircon radiation damage have been examined through annealing experiments and geological observations (Pidgion, 2014; Ginster et al., 2019; Jonckheere et al., 2019; Härtel et al., 2021b). Recent studies indicate T_c values ranging at 330–370 °C for the ν_2 and ν_3 bands, and lower values at 260–310 °C for the ER band, suggesting the potential for a multi- T_c zircon Raman

thermochronometer (Härtel et al., 2021b). Under isothermal annealing for ~ 10 Myr, the partial annealing zone (PAZ) for the Γ_2 and Γ_3 bands is measured ranging around 240–440 °C, and for the Γ_{ER} band ranging around 180–410 °C (Härtel et al., 2021b). However, long-term annealing at temperatures below 100°C can broaden the PAZ to a span over 500°C, complicating geological interpretations based solely on zircon Raman data, and emphasizing the value of integration with ZHe or ZFT thermochronometers (Härtel et al., 2024).

In addition to annealing effects, zircon Raman ages may also be affected by broadened Raman signals arising from radiation damage heterogeneities caused by internal zoning. Multi-band measurements offer a quantitative means to assess partial annealing and band overlap because of the varying sensitivities of the bands (Härtel et al., 2022b). Evidence of partial annealing in an age population is indicated by an average D_3/D_{ER} ratio greater than 1 or by a large subset of grains falling outside the expected error margins in the D_3/D_{ER} - D_{ER} plot (Härtel et al., 2022b). Band overlap is indicated by D_3/D_2 ratios deviating from 0.8–1.2, and grains outside the statistical tolerances in the D_3/D_2 - D_2 plot should be excluded from age calculation and interpretation (Härtel et al., 2022b).

4.3.2 Analytical Procedure

Grain Selection

The separation of zircon grains of the samples was carried out using standard magnetic and heavy liquid separation procedures. Relatively well-formed grains of 100–300 μm long were selected and mounted. Sample mounts were examined at the EOAS department of the University of British Columbia in Canada by cathodoluminescence (CL) and backscattered electron (BSE) imagings. Imaging reveals that grain size, morphology, and zoning patterns vary among samples. Certain samples are dominated by

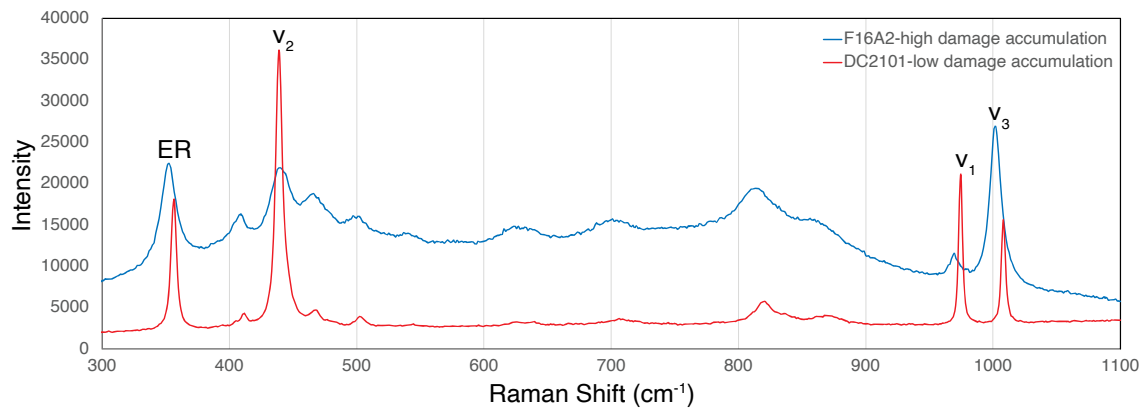


Figure 4.2: Example Raman spectrum of zircon showing four bands (ν_1 , ν_2 , ν_3 and ER), and band shift and broadening of two samples with different degrees of radiation damage accumulation.

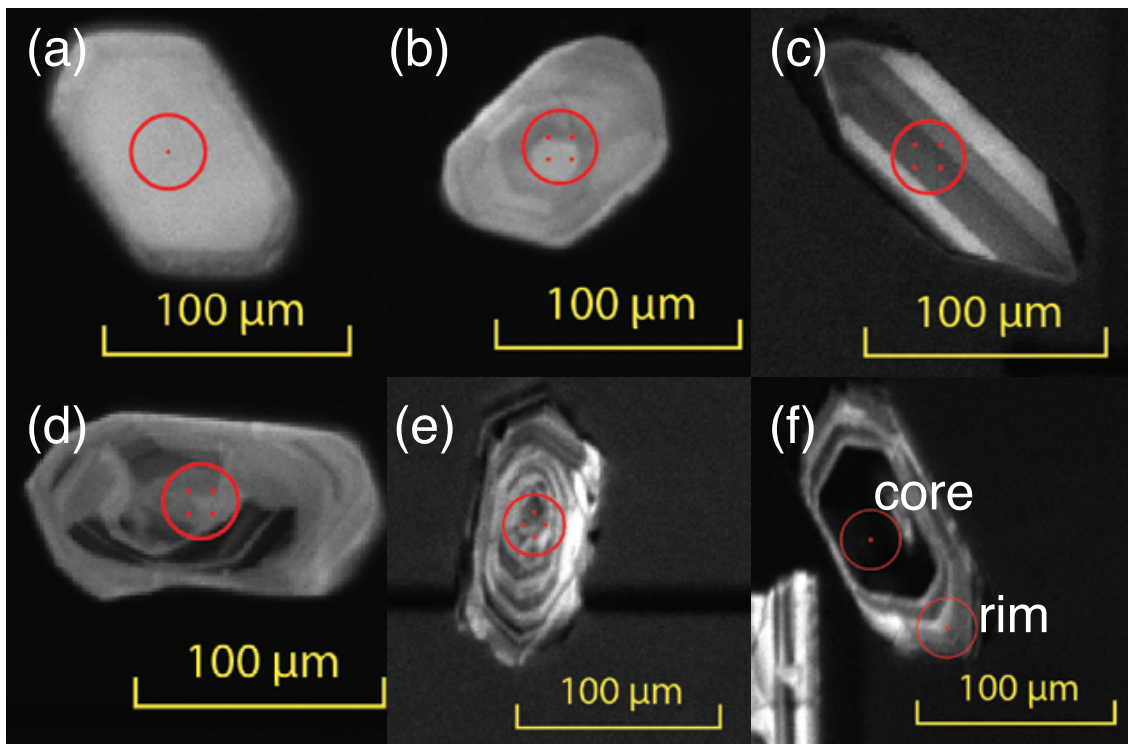


Figure 4.3: Cathodoluminescence images of selected zircons showing various zoning patterns. (a) Homogeneous grain; (b) Cloudy zoning; (c) Banding zoning; (d) Sector zoning; (e) Oscillatory zoning; (f) Core-rim texture. The dots mark one or set of four Raman spots, the circles the target ICP-MS spots.

homogeneous grains or those with weak cloudy zoning, whereas others display grains with distinct oscillatory or sector zoning (Figure 4.3). For each sample, I chose 30–35 grains with few cracks or inclusions, and prioritized homogeneous grains or homogenized area in grains where possible.

Raman Spectroscopy

I collected Raman spectra at the FIPS facility of the University of Victoria, Canada. The spectrometer was connected to a RENISHAW inVia Raman microscope with 5× to 50× objectives. A 532 nm diode-pumped solid-state (DPSS) laser with a maximum power output of 50 mW was employed. Raman spectra were acquired using a 2400

gr/mm grating, a 50 μm slit width and a detector pixel resolution of approximately 0.1 cm^{-1} . The spectrometer was calibrated on the 520.7 cm^{-1} silicon, and its spectral resolution was calibrated to $\sim 1.716 \text{ cm}^{-1}$ referring to the Raman spectrum of the 91500 zircon standard (Bjerga et al., 2022). The spectra were recorded in static mode centered at 700 cm^{-1} from 50 to 1300 cm^{-1} , with 10% laser power and 10 s exposure time. The spot size was 2 μm , and the spot depth exceeded 5 μm . To better represent the volume analyzed by LA-ICP-MS, Raman measurements were conducted on sets of four spots, spaced an average of 10 μm apart, within CL-heterogeneous regions. I determined the band positions (ω) and widths (Γ or FWHM) using an in-house Python script based on IFORS software which uses pseudo-Voigt (PV) profile (a linear combination of the Gauss and Lorentz profile) to fit the Raman bands. I applied instrumental correction to account for bandwidth broadening following the equation provided in Tanabe and Hiraishi (1980). The detailed Raman data are provided in Supplement Table C.1.

LA-ICP-MS Measurements

I measured U and Th concentrations at the ICP-MS Facility of University of Victoria, Canada, using an Agilent 8800 ICP-MS operated in single quadrupole mode coupled to a Cetac LSX-213 G2+ Nd-YAG laser with Hel-Ex 2 sample cell laser ablation system. For each analysis, the laser operated at a 10 Hz repetition rate with a 45 s dwell time, delivering a fluence of 7.14 J/cm^2 (or 35% laser output) through a 30 μm spot diameter. The spots were positioned to align with Raman analysis locations, with preference given to uniform, inclusion-free zones visible in CL and BSE images. Iolite v4 was employed for data calibration and subsequent calculations (Paton et al., 2011; Paul et al., 2023). NIST610 standard glasses and 91500 zircons were used as external standard calibration, and ^{90}Zr was used as an internal standard element assuming an average content of 49 wt% based previous determinations on a wide variety of igneous

and metamorphic rocks (Bea et al., 2006). For quality control, measurements were also performed on reference standards such as NIST612 and NIST614 glasses, along with Mudtank and Plešovice zircons. The U and Th concentrations measured for these reference zircons were compared with the chemical data from previous studies (Wiedenbeck et al., 2004; Sláma et al., 2008; Gain et al., 2019).

4.4 Results

4.4.1 Data Evaluation

Raman and eU data are evaluated to minimize possible biases before calculating the population ages. The assessment includes examining band position-width relationships, asymmetric band and annealing effects, reliability of the chemical concentration measurement and the influence of chemical compositions on the Raman data.

Plots of the band position (ω) against bandwidth (Γ) by Incaplot (Härtel et al., 2022a; Härtel, 2023) in Figure 4.4 and C.1 show typical trends of spectral features of the peaks that broaden and shift to lower wavenumbers as radiation damage increases for the ν_1, ν_3 , and external rotation (ER) bands. The signal from the ν_2 band is masked by the photoluminescence interference induced by the 532 nm laser. For this reason, the ν_2 band is omitted from further interpretation, and discussion below is based predominantly on the other bands. A comparison of signals of the reference sample F16A2 with previously published data shows a good match for the ER band and acceptable minor offset for the ν_1 and ν_3 bands, supporting the reliability of the measurements. All samples in this study exhibit lower radiation-damage accumulation compared to F16A2, as indicated by narrow bands at high wavenumber positions. This is especially for DC2101, which shows almost no shift from a fully ordered zircon (Figure 4.4).

Evaluations of partial annealing and signal overlap are investigated using plots of

$D_3/D_{ER}-D_{ER}$ and D_3/D_2-D_2 , respectively (Figure 4.5). The $D_3/D_{ER}-D_{ER}$ plot (Figure 4.5(A)) shows that data fall within the prediction bands and average D_3/D_{ER} ratios slightly over 1 for most grains. Some samples (VI2208, VI2206, VI2001, F16A2) show elevated D_3/D_{ER} -ratios for some grains and increasing D_{ER} values within prediction interval, indicating gradual cooling through the partial annealing zone (Härtel et al., 2022b). VI2208 exhibits several data points outside the prediction band, indicating higher degree of partial annealing. In the D_3/D_2-D_2 plot (Figure 4.5(B)), most grains yield D_3/D_2 ratios between 0 and 1 within the 90% confidence level, excluding the significant effects of band asymmetry or mixed signals due to heterogeneous zircon zoning. A few grains of some samples that fall beyond the statistical limit in the plot are excluded from sample age calculation to remove the overlap effect.

To evaluate the potential effect of chemical composition on the Raman bandwidth and zircon Raman ages, chondrite-normalized rare-earth element (REE + Hf) concentrations were plotted against the FWHM values of ER band (Figure 4.6 (a-b)), showing a positive correlation for all samples. The $eU-\Gamma_{ER}$ and $eU-REE$ plot (Figure 4.6 (c-f)) further evaluate the effect of radiation damage from the U and Th contents on Raman bandwidth. Both correlations display positive trends of similar form, with VI2208, VI2001, and DC2101 showing a markedly gentler slope due to their distinctly low eU values. By contrast, this feature is not seen in the $REE-\Gamma_{ER}$ plot for these three samples, suggesting a stronger control of eU on Γ_{ER} than that of the trace-element concentrations. In this case, the influence of chemical composition on the Raman spectrum is minor compared to the larger effect of eU (Härtel et al., 2024). Notably, VI2208, VI2001, and DC2101 have markedly lower U and Th contents, while their other trace-element concentrations remain comparable to those of the other samples.

Th and U contents of zircon standards Mudtank and Plešovice were measured in this study and compared with the published literature results as a form of quality control

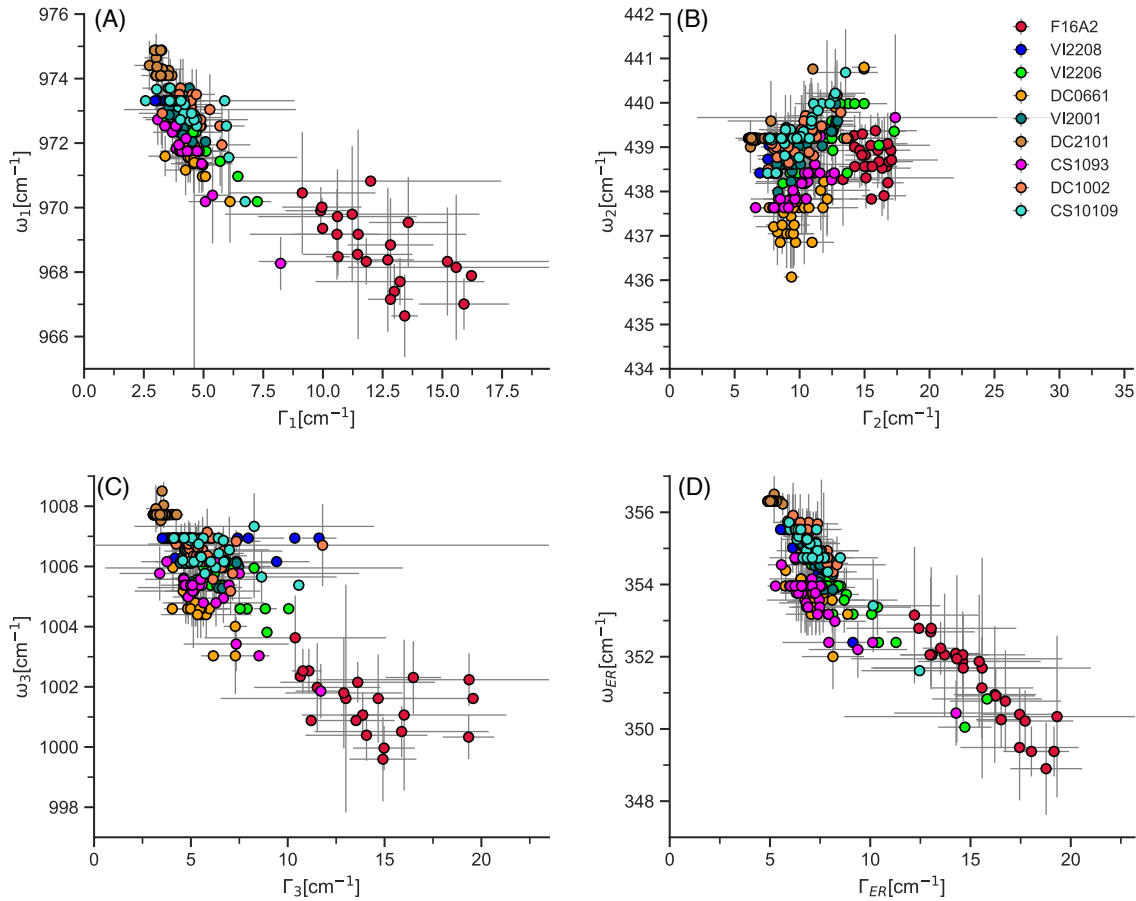


Figure 4.4: Correlation analysis of spectral band position (ω) and bandwidth (Γ) for the $\nu_1(\text{SiO}_4)$, $\nu_2(\text{SiO}_4)$, $\nu_3(\text{SiO}_4)$, and external rotation (ER) bands. Circles in various colors mark different samples, and the bars denote 2σ uncertainties.

on the eU values (Wiedenbeck et al., 2004; Sláma et al., 2008; Gain et al., 2019). As shown in Figure 4.7, all the U and Th results for these two zircon standards are within the acceptance intervals (dashed lines) defined by previous studies, confirming the precision of measured eU for the samples.

4.4.2 Age Calculation

A full dataset is given in Table C.1 and Figure C.2 in the Appendix. Radiation-damage density ($D\alpha$) was calculated from Raman data, and eU concentrations were derived

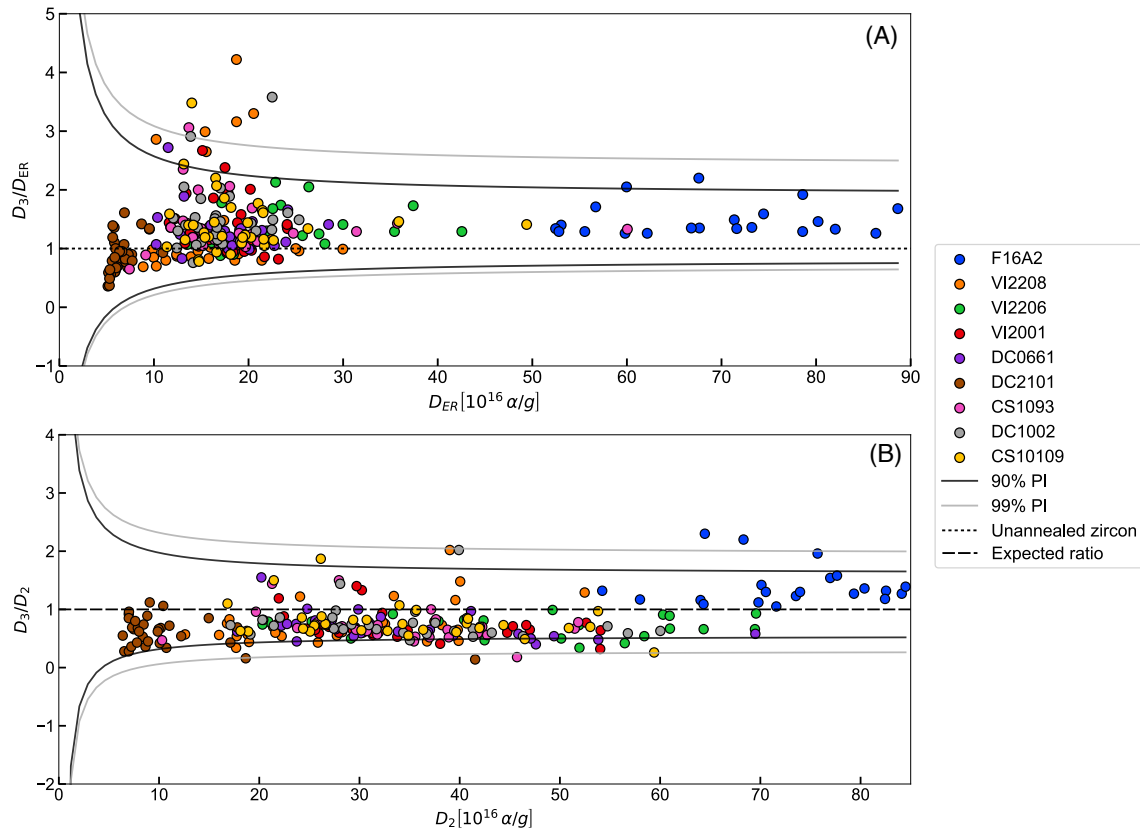


Figure 4.5: Evaluation of Raman data by damage-density ratios. (A) $D_3/D_{ER} - D_{ER}$ with 90% and 99% confidence intervals. The black dashed line indicates the ratio of unannealed zircon. (B) $D_3/D_2 - D_2$ with 90% and 99% confidence intervals. The dashed line represents the expected ratio for symmetric bands. The confidence intervals were calculated for 4% relative uncertainty on damage density.

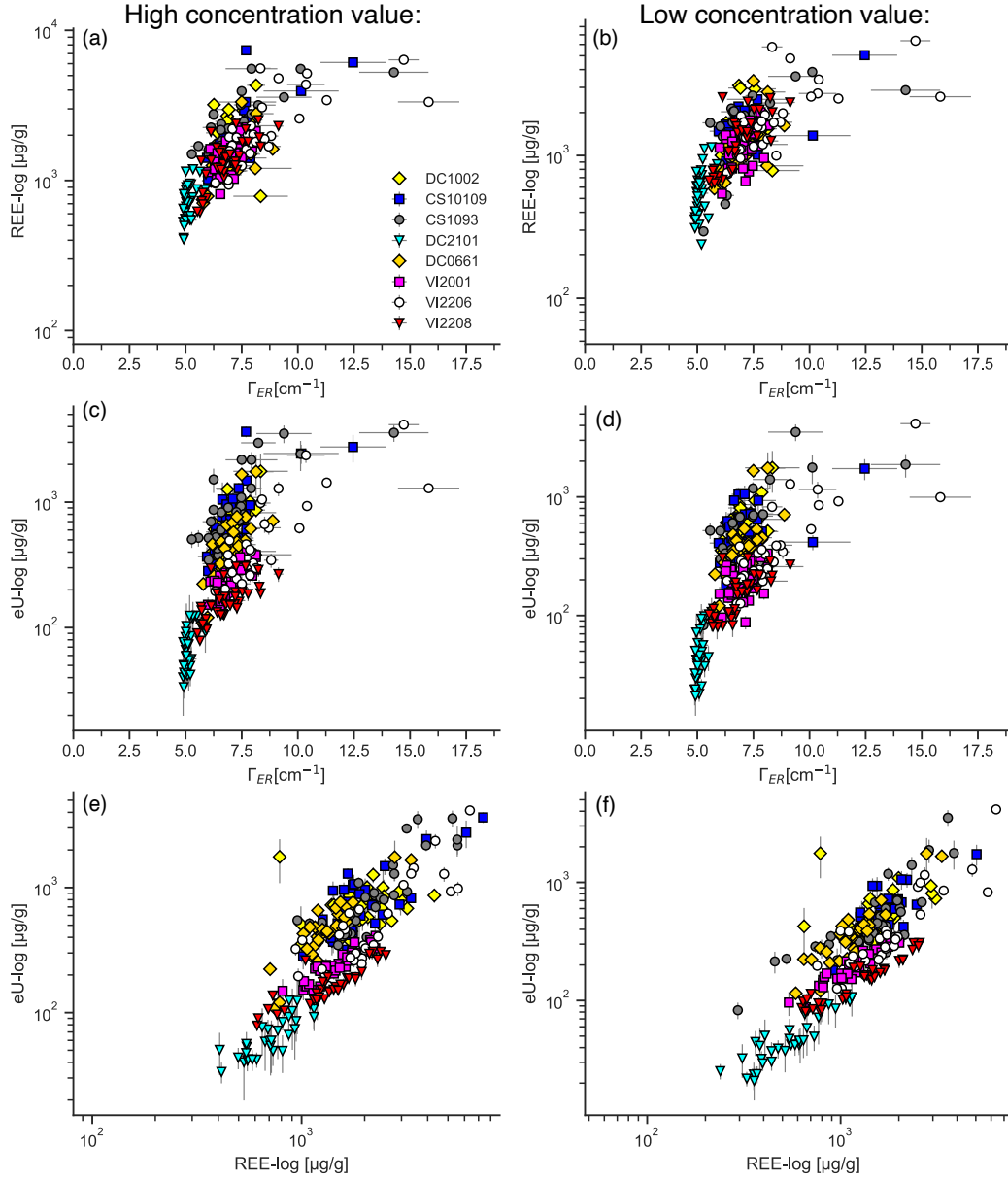


Figure 4.6: Log-scale plots of (a-b) REE- Γ_{ER} , (c-d) eU- Γ_{ER} and (e-f) eU-REE (sum of the light rare-earth element), using highest-concentration data on the left and lowest-concentration data on the right. The bars denote 1σ uncertainty.

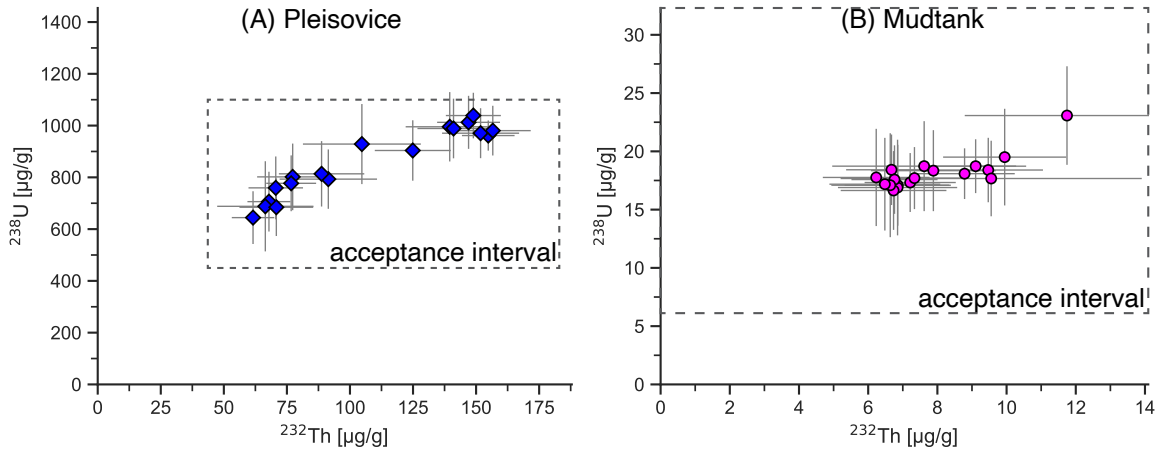


Figure 4.7: ^{238}U - ^{232}Th plot for zircon standards Pleisovice (diamonds) and Mudtank (circles) compared with the typical ranges of published literature results (dashed box) (Wiedenbeck et al., 2004; Sláma et al., 2008).

from LA-ICP-MS data, following the calibration of Härtel et al. (2021a). Single-grain dates for 9 samples (30–35 grains each) were subsequently determined from $D\alpha$ and eU for the ν_1 , ν_2 , ν_3 and ER bands. To determine the representative sample age, I tested three statistical measures for the reference sample F16A2 (Figure 4.8): a pooled age (combined isotope measurements), a weighted isochron age (uncertainty-weighted average), and a robust isochron age (regression slope adapting approach of Powell et al. (2020)). These were derived from daughter-parent (D-eU) plots following the approach of Härtel et al. (2022a). I prioritized ages derived from the ν_3 and ER bands. This is because the ν_1 band has low intensity and no established annealing model, and the ν_2 band is contaminated by overlapping photoluminescence signals from excitation of rare-earth elements induced by the 532 nm laser. Therefore, sample ages for the ν_2 band are withheld and not reported.

As shown in the D-eU plots for F16A2 (Figure 4.8), among the three sample age types, the weighted regression ages yield the most reliable results. This is because the robust method assigns less weight to ages that deviate from the central ‘spine’ line, making it less reliable for overdispersed populations (Powell et al., 2020). The high MSWD value (Mean Square of Weighted Deviates) over 1 confirms that overdispersion is prevalent in our samples, making the robust method less reliable. A pooled age also fails in this scenario since it will force a single average age onto a heterogeneous population, producing a meaningless result that hides the geologic complexity. A weighted regression age points around a best-fit line only due to analytical uncertainty (Kullerud, 1991), and potential outliers are removed before age calculation to minimize the skewness.

Pooled and weighted regression ages for 8 samples are given in Table 4.1 and Figure 4.9. For each band, I provide a pair of ages calculated from the highest and lowest eU values, constraining a range of sample ages. For the reference sample F16A2, ν_3

band ages are 274–372 Ma across different age calculation methods, consistent with the reference ages of 286–568 Ma derived from Härtel et al. (2021a), confirming the data reliability obtained in this study.

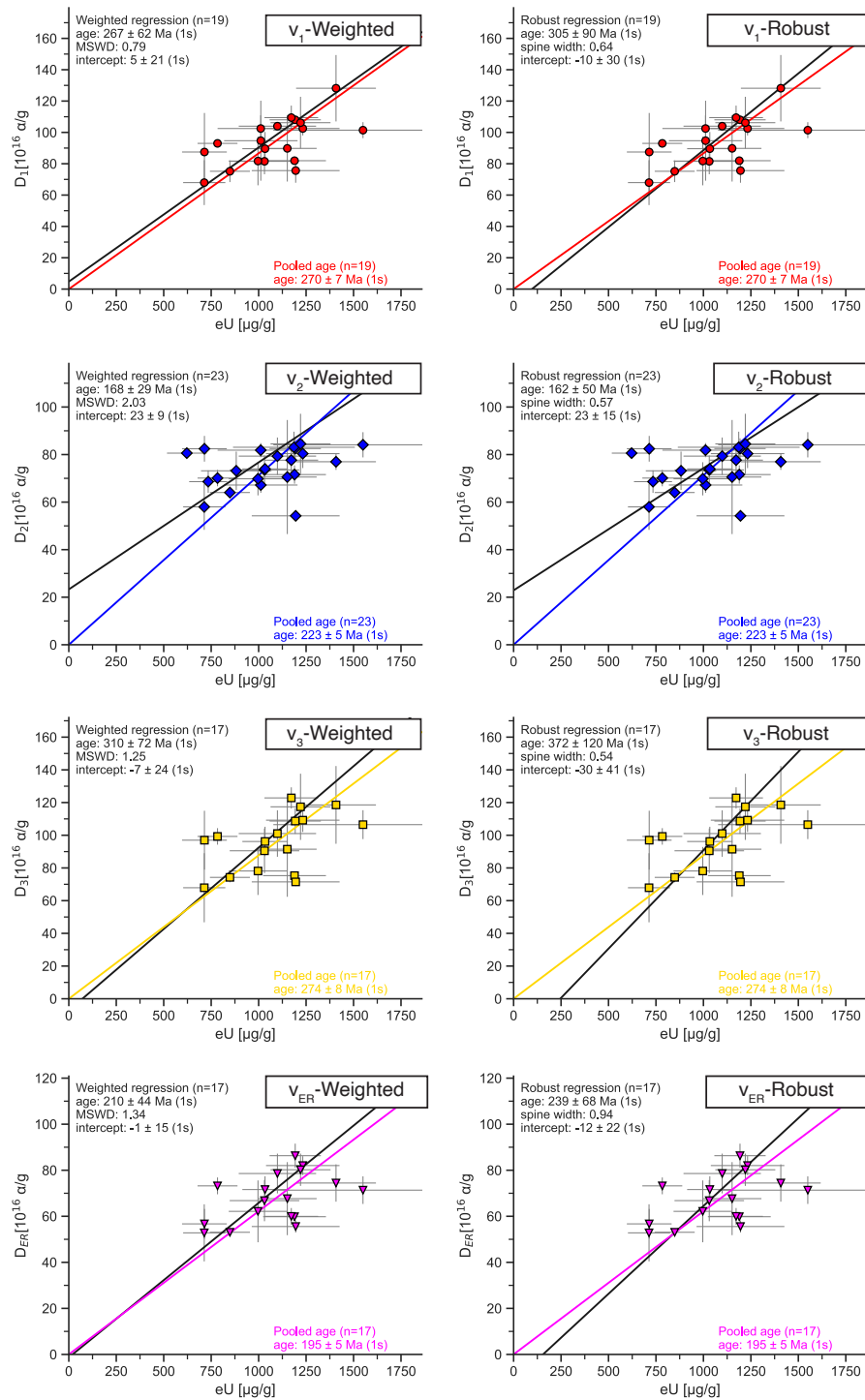


Figure 4.8: Alpha dose-eU plots for ν_1 , ν_2 , ν_3 and external rotation (ER) bands of F16A2 using Incaplot (Härtel et al., 2022a; Härtel, 2023), displaying three types of sample ages: the pooled, the Weighted and Robust isochron ages (1 σ). MSWD: Mean Square of Weighted Deviates.

Table 4.1: Summary of sample information, ages and uncertainties. Zircon Raman ages for each band in this study include the pooled and weighted isochron ages. All uncertainties are reported in parentheses as 1sd.

Sample	Long (°)	Lat (°)	Elevation (m)	Weighted isochron age (1s) (Ma) ^c					
				ν_1 -low	ν_1 -high	ν_3 -low	ν_3 -high	ν_{ER} -low	ν_{ER} -high
VI2208	-127.87	50.72	226	124(9)	127(10)	404(23)	430(22)	313(18)	346(19)
VI2206	-126.90	50.52	164	76(5)	113(9)	150(7)	179(10)	67(3)	89(5)
VI2001	-123.67	48.68	94	230(18)	287(21)	349(25)	499(34)	212(14)	333(19)
DC0661	-124.40	49.07	336	53(8)	79(12)	98(7)	127(11)	76(6)	80(7)
DC2101	-125.22	49.75	648	242(27)	248(28)	229(34)	298(47)	189(21)	197(20)
CS10-93	-125.98	49.26		18(4)	32(6)	34(5)	54(10)	22(2)	39(5)
DC1002	-125.96	49.26		45(8)	47(7)	88(12)	123(16)	40(7)	43(7)
CS10-109	-125.90	49.26		42(7)	68(9)	152(14)	276(27)	32(4)	52(6)
Sample	Sampling ^a	Suite ^b	Lithology	Pooled age (1s) (Ma) ^c					
				ν_1 -low	ν_1 -high	ν_3 -low	ν_3 -high	ν_{ER} -low	ν_{ER} -high
VI2208	hand	IPS	diorite	304(4)	342(4)	287(4)	324(4)	304(3)	349(4)
VI2206	hand	IPS	diorite	160(3)	219(4)	196(3)	264(4)	146(2)	194(3)
VI2001	hand	IPS	diorite	260(4)	331(5)	258(3)	325(4)	220(2)	270(3)
DC0661	hand	IPS	granodiorite	161(3)	211(4)	146(4)	188(5)	119(2)	154(3)
DC2101	hand	Mt. Washington	qz diorite	552(17)	767(22)	236(10)	334(12)	284(9)	401(12)
CS10-93	core	Catface	qz diorite	74(2)	116(2)	79(3)	130(4)	61(1)	104(2)
DC1002	hand	WCC	qz monzonite	104(3)	132(4)	109(3)	133(4)	80(2)	97(2)
CS10-109	core	Vancouver Group	qz monzonite	85(2)	108(3)	108(3)	133(4)	77(2)	98(2)

Note: Samples are stored in the collections of the University of Victoria, School of Earth and Ocean Sciences, Victoria, BC V8W 2Y2, Canada.

^aSampling methods include in-situ hand pick and drill core.

^bSuite: Name of stratigraphic unit sampled. IPS - Island Plutonic Suite. WCC - West Coast Complex.

^cEach band provides a pair of ages (with uncertainties), calculated from the highest and lowest eU values.

4.5 Discussion

4.5.1 Age Inversion Analysis

While most Raman ages are younger than the crystallization ages, consistent with post-emplacement cooling (Figure 4.9), samples VI2208, VI2001, and DC2101 show pronounced grain-age dispersion skewed toward older ages (Figure 4.10), producing anomalously old sample ages that exceed their corresponding U–Pb zircon ages and require further investigation (Table 4.2). The spuriously old ages for DC2101 can be explained by its anomalously low radiation damage, revealed by low FWHM and high band positions on its Raman spectra, which are similar to that of a fully ordered zircon (Figure 4.4). Under this low damage state, the Raman signals become highly susceptible to minor inaccuracies and the damage calibration is less robust. In the case of DC2101, the combination of highly uncertain damage density and low eU likely produced a broad distribution of grain ages, yielding an unreliable old age estimate.

In the low-damage regime, other factors such as grain chemistry and bias in parent isotope measurement could play a role. Grain chemistry generally has only a minor influence on the Raman bandwidth, though its impact can become noticeable when radiation damage is low. Evaluation of all samples in the preceding section shows that chemical composition exerts a small effect on Raman bandwidth relative to the primary control of eU. Nevertheless, samples with exceptionally low eU shown for VI2208, VI2001 and DC2101 (Figure 4.6) correspond to the anomalously old ages, undermining the reliability of Raman age determination for low-eU zircons. Additionally, systematic biases in U and Th measurements as a source of the abnormally old ages are eliminated by calibrating them against reference materials (91500, Mudtank and Pleisovice) analyzed in previous work. The reliability of the parent-isotope concentrations is con-

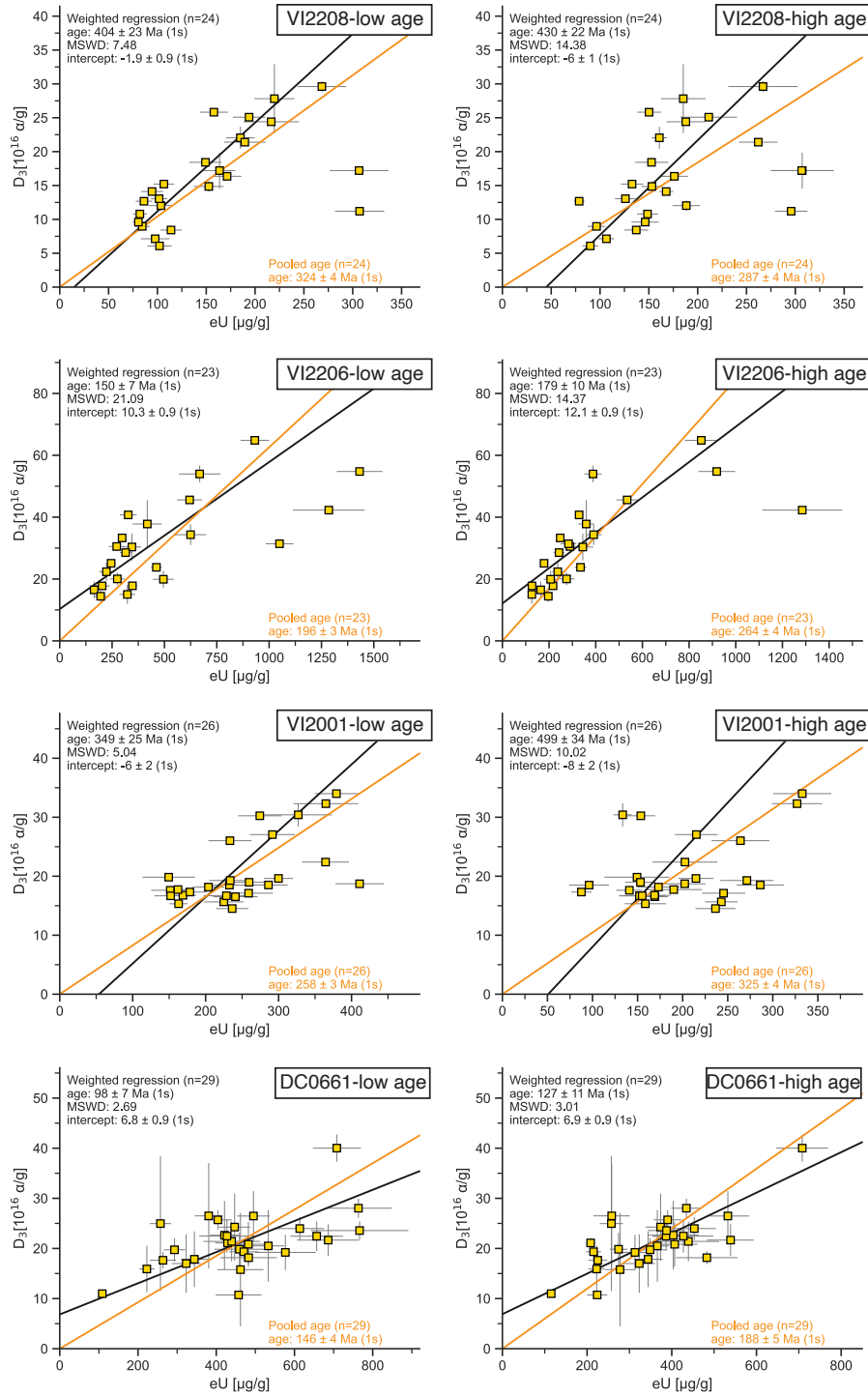
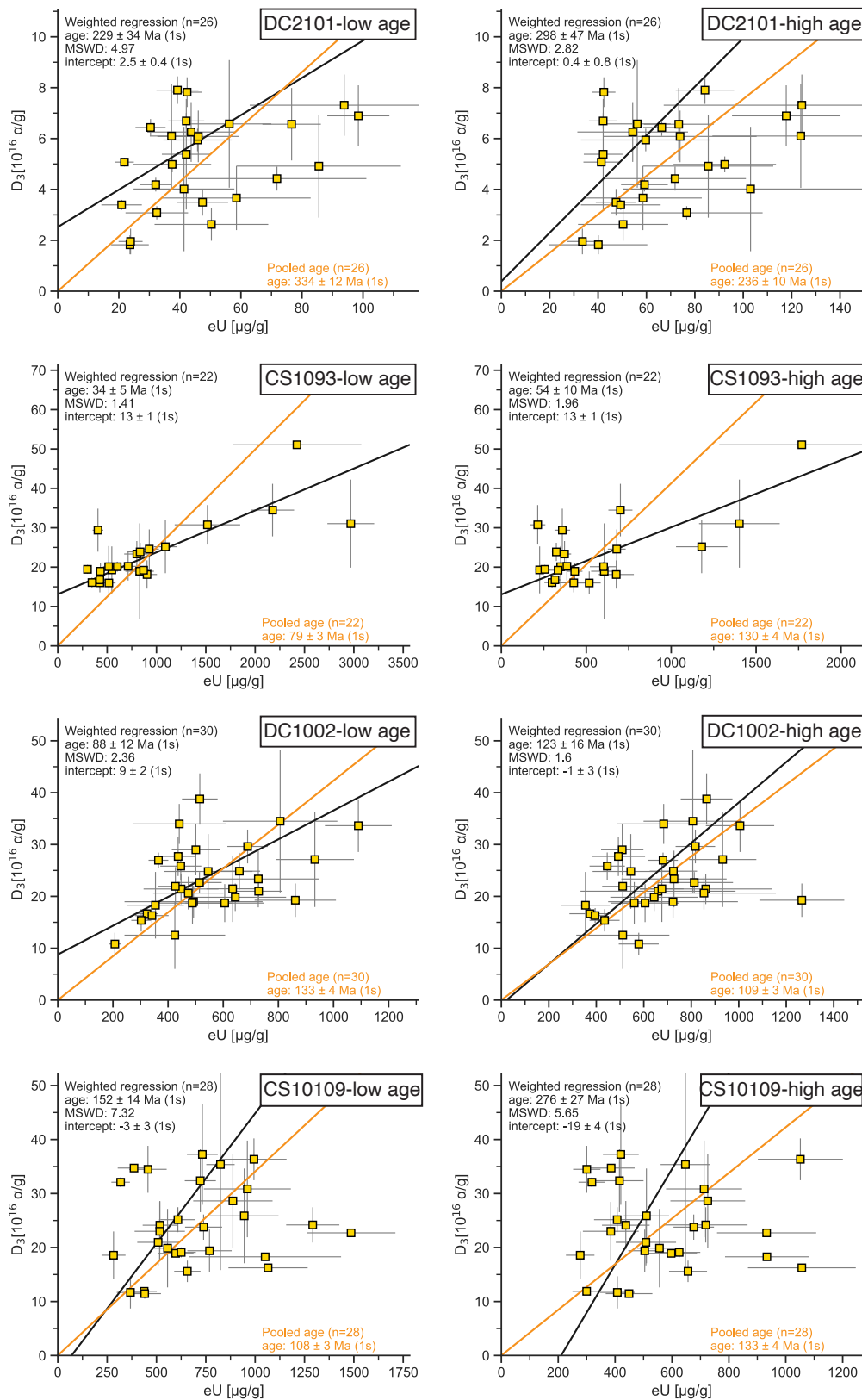
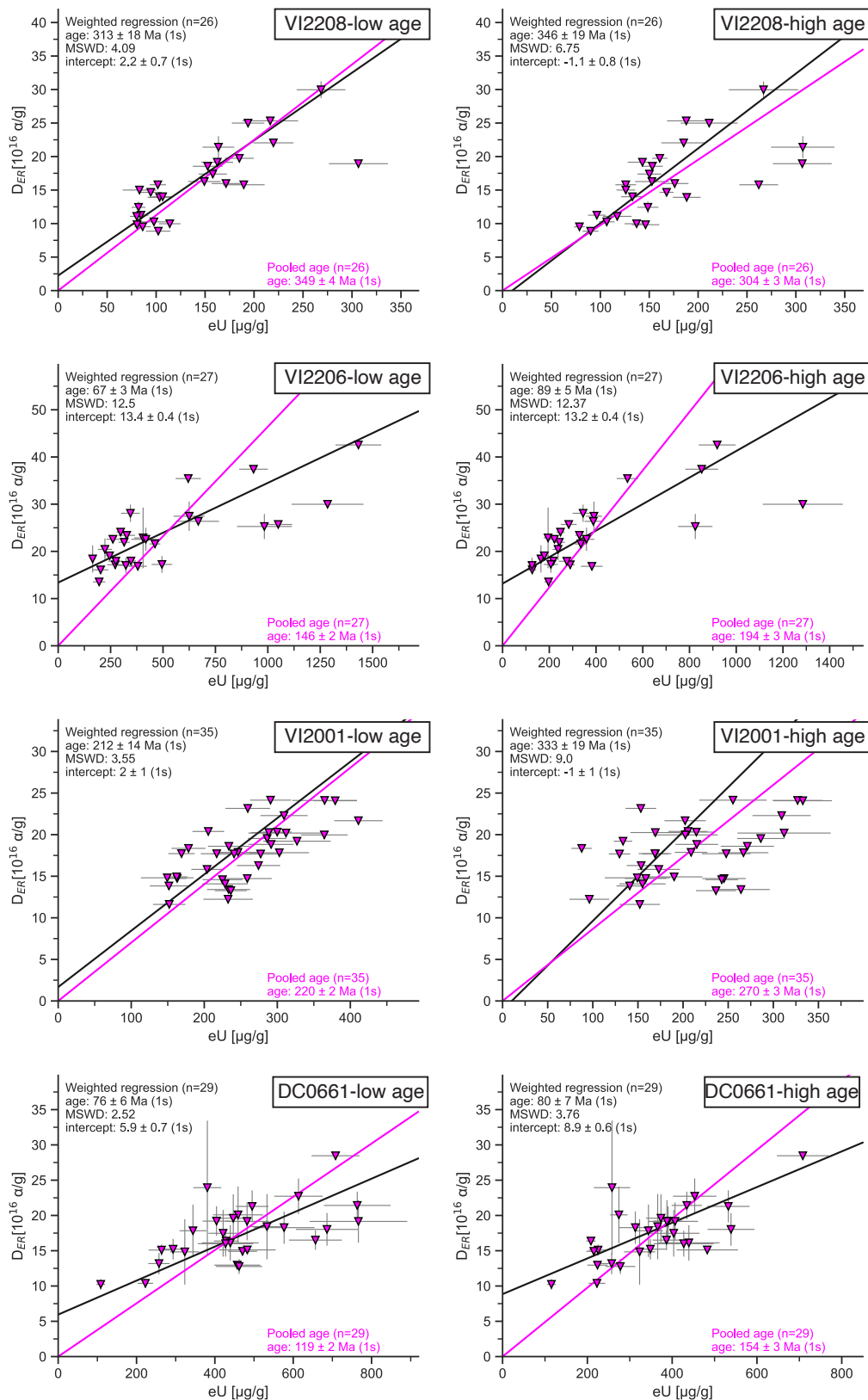
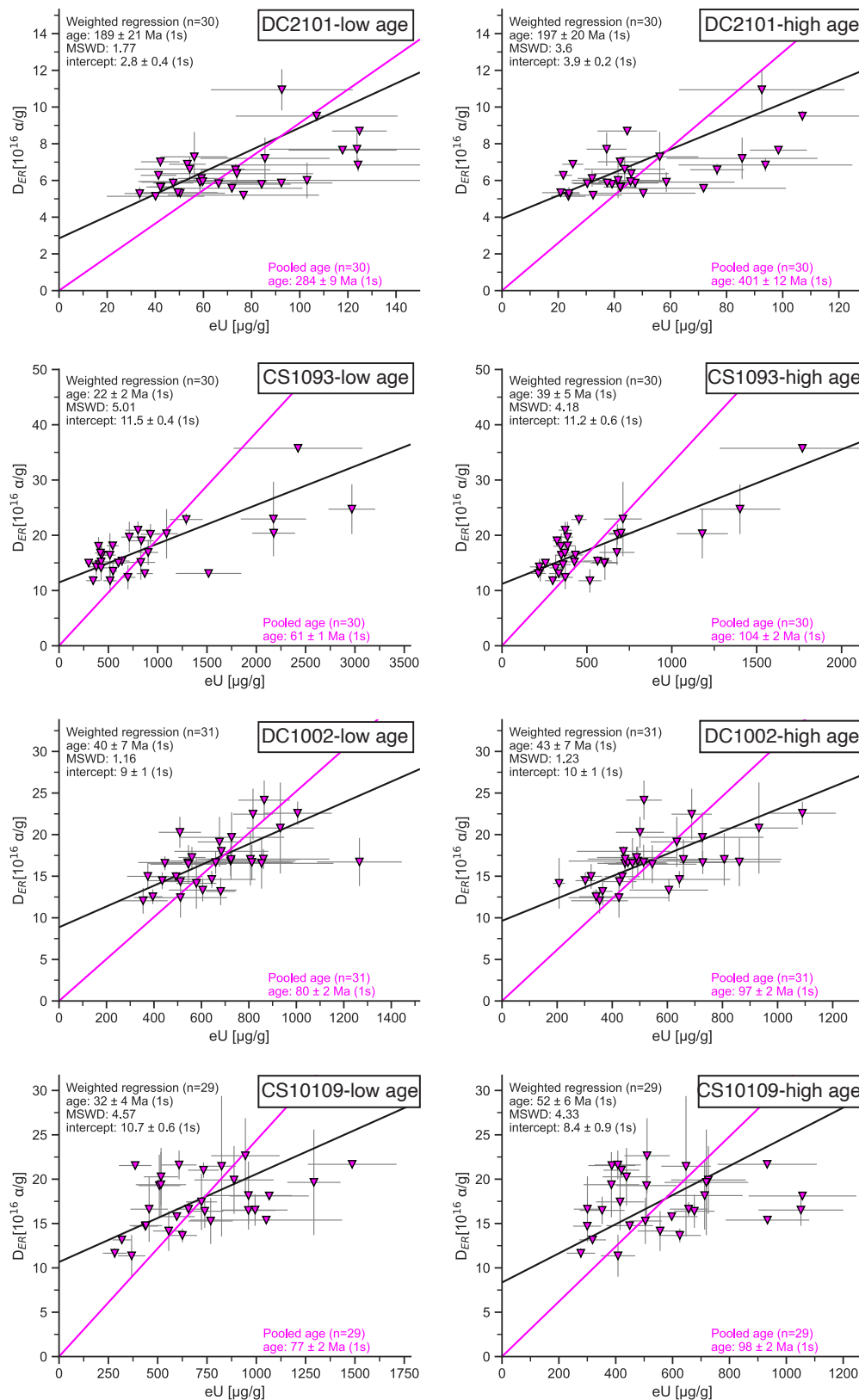
(a) ν_3 band

Figure 4.9: Alpha dose-eU plots for ν_3 and external rotation (ER) bands of the samples using Incaplot (Härtel et al., 2022a; Härtel, 2023), marking the uppermost and lowermost values of the pooled and weighted isochron ages.

(b) ν_3 band



(c) ER band



(d) ER band

firmed.

Another analytical factor potentially responsible for the age inversion is band broadening and asymmetry resulting from the mixing of Raman signals from heterogeneous domains or from internal strain. Broadening of the main Raman bands leads to inflated bandwidths and exaggerated damage densities, ultimately generating apparent ages that are older than the true geological signal. Compared with the other samples, CL images of VI2208, VI2001, and DC2101 reveal more uniform internal zoning (Figure C.3). The analysis of Raman signal overlap and the exclusion of outliers in the Results section serve to reduce the impact of this factor. Thus, band asymmetry can be excluded as a contributing factor to the age inversion.

An alternative explanation for the anomalous zircon Raman ages involves geologic complexity. Both VI2208 and VI2001 show overdispersive pattern and relatively low eU characteristics. Such overdispersion is likely linked to geological processes such as long-term radiation damage accumulation and subsequent annealing, leading to exaggerated age estimates particularly for low-eU grains. An alternative explanation for the broad age distribution is the mixing of age components or inheritance of some zircons in the population from older country rock that the pluton intruded. In the case of sample VI2001, this rock was sampled at the boundary between the Sicker Group and the Island Plutonic Suite, and has no independent U-Pb zircon date. Although VI2001 was presumed to be a Jurassic pluton, it may belong to the nearby Devonian Sicker Group of ~ 350 Ma.

In summary, in addition to the intrinsically low radiation damage for sample DC2101, the main reason for these spuriously old results could be an overdispersed age population caused by long-term damage accumulation and annealing in low-eU zircons. Inheritance from an earlier neighbor intrusion could be a minor influence.

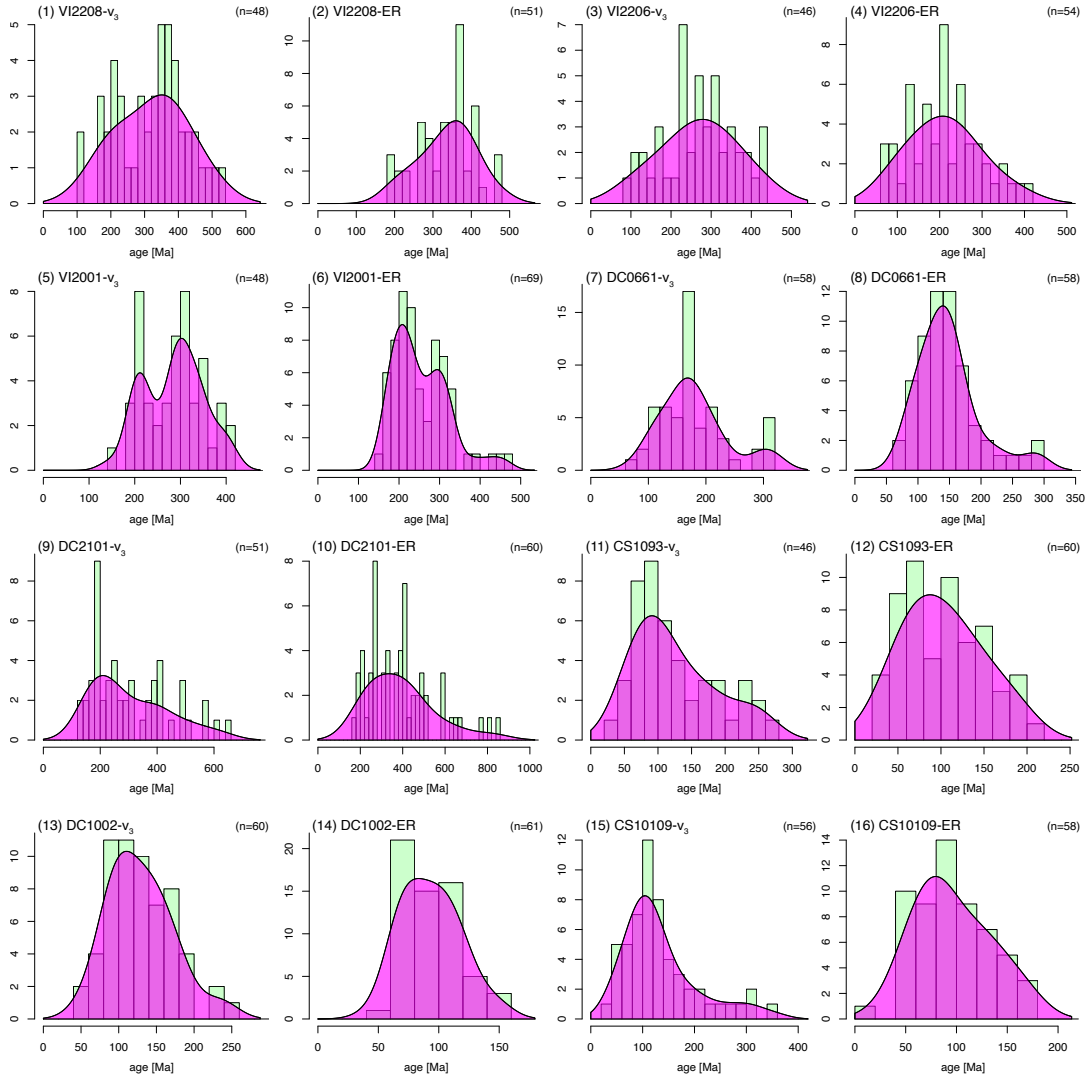


Figure 4.10: Kernel Density Estimate (KDE, pink distributions) of grain-age distributions (green bars) for all the samples (ν_3 and ER bands). All plots were generated in IsoplotR (Vermeesch, 2018).

Table 4.2: Summary of previous thermochronological ages and uncertainties.

Sample	UPb (Ma) ^a	Zircon Ra- man range (ν_3 , Ma) ^b	ZHe Mean (Ma) ^c	ZHe 1se (Ma)	AFT Central (Ma) ^c	AFT 1se (Ma)	AHe Mean (Ma) ^c	AHe 1se (Ma)
F16A2	309	310						
VI2208	170	404-430	146.5	5.9			28.7	1.7
VI2206	183	150-179	145.6	3.6			32.6	2.2
VI2001	180	349-499	48.2	6.2	60.5	5.9	33.5	1.9
DC0661	180	98-127	57.4	7.4	43.8	5.5	29.3	2.8
DC2101	35	229-298			94.9	31.2	33.6	3.0
CS10-93	41	34-54	35.9	0.4	49.2	6.4	28.6	1.4
DC1002	186	88-123						
CS10-109	184	108-152						

Note: Samples are stored in the collections of the University of Victoria, Victoria, BC V8W 2Y2, Canada.

^aReference U-Pb ages are from previous studies (Smith et al., 2012; Canil et al., 2013; Canil and Morris, 2024)

^bPreferred sample age ranges of zircon Raman dating for ν_3 band in this chapter.

^cOther thermochronological ages are referred to previous chapters in this work.

4.5.2 Thermal History Interpretation

The zircon Raman ages can be compared with the results of other thermochronometers used in previous chapters on the same samples (summarized in Table 4.2). Figure 4.11 illustrates the time-temperature path for each sample obtained by thermal modeling in the previous chapter, with the zircon Raman weighted regression age and other thermochronologic ages plotted within their corresponding closure temperature ranges. Samples DC0661, CS1093 and VI2206 show a good fit between the observed zircon Raman ages and the ages predicted by the thermal models.

To test for possible thermal effects of the Eocene plutons on the Raman ages of nearby rocks, I compare the thermal histories of the two plutons emplaced at 41–35 Ma (CS1093, DC2101) with those of their adjacent older plutonic country rocks (DC1002, CS10109), which were emplaced around 185 Ma (Figure 4.11). The Early Cretaceous ages for the ν_3 band of DC1002 and CS10109 indicate the country rocks were not fully reset by the Eocene plutonic emplacement at 41–35 Ma. In contrast, the Eocene ages obtained from the Raman ER band for both samples are consistent with the timing of the younger intrusion. This indicates that the ER-band Raman ages have been thermally reset by the Eocene plutons, reflecting the higher susceptibility of this band to annealing compared with the more resistant ν_3 band. Together, this contrast demonstrates that analyses of multiple bands provide a valuable multi-sensitivity framework for interpreting zircon Raman ages: the ν_3 band can constrain stable and long-term thermal history, while the ER band may record more localized or younger heating events.

The results of most samples show good agreement with previously constructed thermal history models, and thus demonstrate the capability of zircon Raman dating to capture cooling within a temperature window of 260–370 °C, slightly above the ZHe closure temperature range. The robust Raman-age predictions for the VI2206 and

DC0661 provide additional constraints on the rapid Jurassic cooling of northernmost Vancouver Island and the more uniform, moderate cooling of the southern island during the Early Cretaceous. Additionally, the two samples adjacent to the Eocene plutons yield Raman ages that show good concordance, indicating similar thermal history. The age discrepancy between the ν_3 and ER bands of these samples indicates that local thermal events could have reset the ER-band Raman ages in nearby areas, given the band's high sensitivity to annealing.

4.6 Conclusions

This work examines the applicability of the newly developed zircon Raman dating method on eight igneous samples with distinct thermal histories (rapid cooling, multi-stage cooling, and prolonged residence in PAZ) from Vancouver Island. Our Raman and ICP-MS analyses yield sample ages for the ν_3 band that range from 34–54 Ma for CS1093 to 349–499 Ma for VI2001, and for the ER band that range from 22–39 Ma for CS1093 to 313–346 Ma for VI2208 (1σ , weighted isochron age). Overall, five samples produce reasonable zircon Raman ages, compatible with thermal histories established from other thermo- and geochronometric methods, whereas the other three display anomalously old ages. These spurious outliers are interpreted as samples characterized by low radiation-damage densities and by low eU contents that have undergone long-term thermal histories. Samples adjacent to the Eocene plutons yield Cretaceous ν_3 -band ages but Eocene ER-band ages, highlighting the greater sensitivity of ER band to localized thermal disturbances and demonstrating the value of a multi-sensitivity approach in interpreting zircon Raman ages. This study reinforces the reliability of the evaluation procedure of the zircon Raman dating method and the previously constrained 330–370 °C closure interval for the ν_3 band and interval of 260–310 °C for

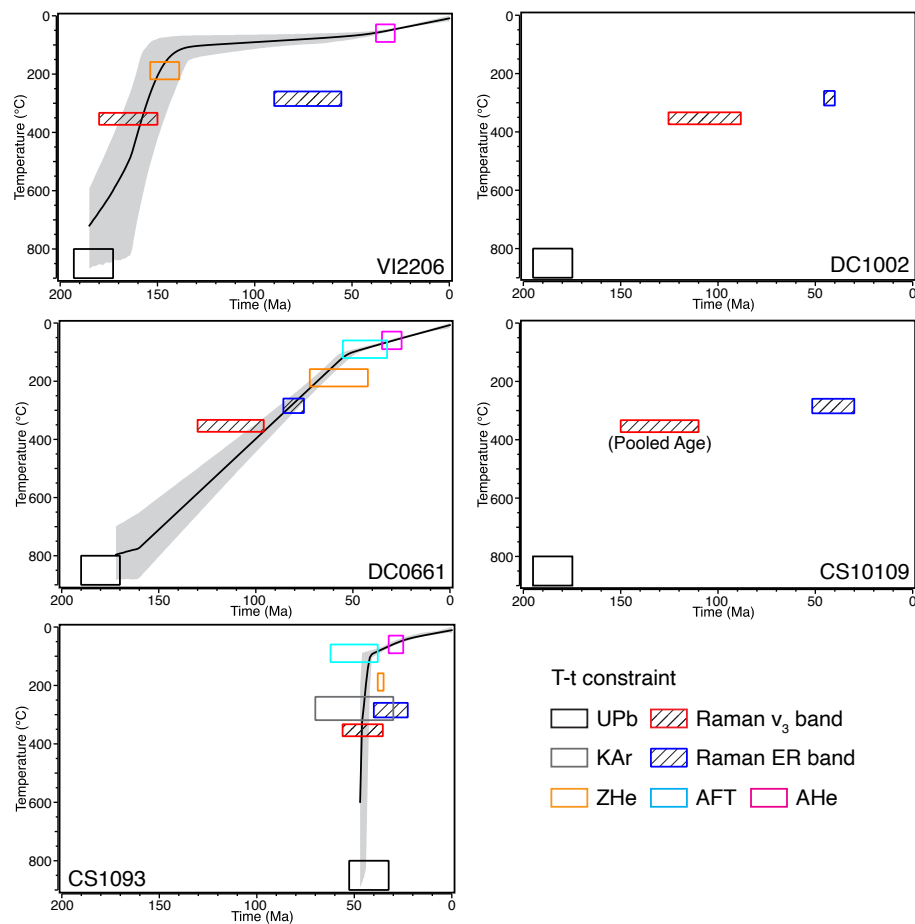


Figure 4.11: Comparison of zircon Raman ages and other thermochronological results. The thermal histories are modeled in the last chapter based on ZHe, AFT and AHe data. The boxes in various colors indicate the time-temperature constraints based on age data from previous and this work. It includes the width of sample age with uncertainties and the height of nominal closure temperature range (AHe:40–80 °C; AFT:60–120 °C; ZHe:160–220 °C; KAr(Bt):240–310 °C; Raman ER band:260–310 °C; Raman ν_2 , ν_3 bands:330–370 °C; UPb:800–900 °C). For the Raman constraints, the bar width represents the age range calculated using the highest and lowest eU values (no uncertainty information).

the ER band. Although further refinement of the technique is needed, zircon Raman dating provides a simple, fast and cost-effective tool that can be integrated with other thermochronometers like zircon U-Th/He. From a geological perspective, the zircon Raman data reinforce earlier constraints on Vancouver Island's variable cooling history and align with the interpretations discussed in the prior two chapters.

Chapter 5

Conclusions

5.1 Research Overview

This thesis establishes a robust framework from multiple research projects for understanding the burial and exhumation histories of the Jurassic Bonanza arc and younger rocks on Vancouver Island, Canada, using multiple low temperature thermochronometers covering the extent of the entire island. This chapter synthesizes the key findings from the previous chapters to construct an integrated model of the thermal and exhumation processes in the upper crust of Vancouver Island.

In chapter 2, integration of AFT and AHe age data and thermal history inversion from southern Vancouver Island, combining previously published AFT ages, show a mainly Paleocene to Oligocene cooling history, including 70–30 Ma quiescent cooling before slow uplift of the western side, uniform slow cooling of the central region and accelerated cooling of the eastern ranges. The spatial variations of the exhumation pattern reveal uplift related to crustal shortening of the Cowichan Fold and Thrust Belt following the oroclinal development during accretion of the Siletzia terrane. At the same time, southern Vancouver Island was probably covered by shallow sedimentary strata, unroofing of which on the west coast resumed since ~30 Ma, probably linked to Pacific-Farallon ridge migration and Cascadian subduction.

Chapter 3 extends the low-temperature thermochronological study to central and northern Vancouver Island, and integrates ZHe, AFT and AHe ages with thermal history models. The results suggest different exhumation patterns in the northernmost region compared to the rest of the island. A shift from fast to slow cooling was identified in most of the island since ~50 Ma, reflecting the decrease of convergence and

exhumation rate following fragmentation of the northern Farallon plate and initiation of the Cascadia subduction zone. In contrast, prolonged slow cooling was recorded in the northernmost region exceeding 70 Myr before ~ 40 Ma, which is interpreted to reflect the northward, coast-parallel motion of the Kula/Resurrection plate along the margin of northernmost Vancouver Island. The northern boundary of the Eocene Cascadia subduction zone was thus constrained around the northern island, shifting north around 40 Ma after which the northernmost island was exhumed at the same rate as the remainder of the island.

Finally in chapter 4, the recently developed zircon Raman dating method is employed to complete the low-temperature thermochronological record for Vancouver Island within the 260–370 °C range and to evaluate its applicability to intrusive samples exhibiting distinct thermal histories. The zircon Raman data from this study generally align with the ages derived from other thermochronometric methods, corroborating the existing model for Vancouver Island’s thermal history. However, the technique requires further refinement, as indicated by a few outliers that yield spuriously old ages. This is particularly true for samples with low radiation-damage densities or those with low eU contents that have experienced complex thermal histories. The results also show that the ER band is considerably more sensitive to localized thermal events than the other bands, emphasizing the advantage of a multi-sensitivity framework in zircon Raman age interpretation. Integrating zircon Raman dating with other thermochronometers such as ZHe can enhance the reliability of its age interpretations.

5.2 Evaluation of Existing Hypotheses

This work moves beyond previous work by providing new perspectives and data to reassess existing hypotheses for crustal deformation and exhumation of North American

margins. For example, this study demonstrates that oceanic plateau translation does not produce sufficient vertical uplift and upper-crustal cooling along the continental margin, calling into question the hypothesis that Haida Gwaii exhumation was driven by Yakutat terrane translation (Schoettle-Greene et al., 2020). Were this hypothesis correct, one would expect a northward-younging pattern of cooling ages from Vancouver Island to Haida Gwaii, consistent with the northward migration of the Yakutat terrane. However, such a pattern is not observed in the dataset along the axis of Vancouver Island. Only limited uplift and exhumation along the southern Alaskan margin have been shown to result from Yakutat subduction since the early Miocene, where tectonic motion shifted from strike-slip to convergence (Enkelmann et al., 2010, 2017).

In addition, the data and interpretations presented here are not consistent with thermal resetting or enhanced exhumation driven by a long-lived slab window beneath the crust north of northern Vancouver Island. Such a slab window may have contributed to lithospheric thinning, elevated surface heat flow, and upper-crustal extension (Rohr and Currie, 1997; Madsen et al., 2006; Thorkelson et al., 2011). However, the thermochronological data in this work do not record younging signals attributable to either thermal reheating or accelerated exhumation associated with asthenospheric upwelling, suggesting a very limited tectonothermal influence of a slab window. Indeed, the thermochronological ages from the northernmost region in this study are significantly older than those from central-southern Vancouver Island, inconsistent with the thermal or exhumational effects predicted by a slab-window-driven mechanism. Together, these observations indicate that slab-window processes did not play a primary role in controlling upper-crustal cooling along this segment of the northwestern North American margin.

The primary forces driving exhumation along the northwestern North American margin are found to be the convergence and collision of oceanic domains across the

boundary in this study. Initially, paired crustal shortening and extension on southern Vancouver Island were observed as an exhumation response to the collision of the Siletzia terrane with the southern margin during the Eocene. Secondly, the transition from the pre-Eocene tectonic regime of the southern Farallon subduction zone to a northern transform Kula / Resurrection margin off northern Vancouver Island is distinguished by linking exhumation spatial patterns to changes in convergence motion. Furthermore the data show, localized near-trench magmatism exerts only a minor influence on the cooling histories of surrounding samples. Taken together, this work suggests that regional and localized tectonic motion is the dominant control on uplift and exhumation of northwestern North American margins, superseding alternative models about Yakutat terrane translation and slab-window formation.

5.3 Tectonic Evolution of Vancouver Island

The intrusive rocks of the Bonanza Arc were emplaced into the Mesozoic basement of Wrangellia between 205 and 165 Ma, forming the bedrock of much of Vancouver Island. After rapid post-emplacement cooling, these intrusions experienced different uplift and cooling histories prior to the Eocene resulting from two tectonic regimes. One is a quiescent phase for over 70 Myr under proposed northward, coast-parallel motion of the Kula / Resurrection plate along the margin offshore northernmost Vancouver Island. A second phase involved uniform fast cooling throughout the main portion of the island, a region adjacent to the ancient Farallon subduction zone. The pre-Eocene Farallon – Kula/Resurrection ridge at the trench has therefore been identified offshore northern Vancouver Island for the first time.

The major tectonic reorganization and change in the exhumation pattern occurred between 55 and 40 Ma off the west coast of North America. During this period, the

northern portion of the Farallon plate fragmented, giving birth to the Juan de Fuca Plate, which subducted along the Cascadia margin south of the Farallon - Kula / Resurrection ridge. This plate rearrangement led to a decrease in convergence and exhumation rate of the major Vancouver Island that was at the leading edge of the overriding plate. At the same time, the Siletzia terrane was accreted to the southern margin of the island, leading to oroclinal bending of southern Vancouver Island and crustal shortening of the Cowichan Fold and Thrust Belt, revealed by the exhumation response in this region. Conversely, the western side's exhumation pattern supports the hypothesis that the region was overlain by sedimentary strata during the Eocene, probably an equivalent of the Pacific Rim terrane's accretionary complex that was later subducted beneath the margin. Meanwhile, the Eocene near-trench magmatism, related to the plate reorganization between 51 and 35 Ma, occurred in sparse locations. This is confirmed by rapid cooling patterns in localized samples. The Farallon - Kula / Resurrection ridge is interpreted to have migrated northward at approximately 40 Ma in this work, subsequent to either the complete subduction of the Resurrection plate beneath southern Alaska or the Pacific plate's capture of the Kula plate. Uniform slow exhumation driven by Cascadia subduction was established across Vancouver Island following the shift of the Juan de Fuca boundary, consistent with previous studies (Madsen et al., 2006; Wells et al., 2014; Fuston and Wu, 2021).

5.4 Contributions and Future Directions

This thesis reconstructs the spatiotemporal history of exhumation on Vancouver Island and provides new insights into plate convergence and margin evolution through integrated low-temperature thermochronology. Before this work, the location of the pre-Eocene Kula-Farallon ridge and the initiation of Cascadian margin were unclear

and oversimplified. In this study, the onset of Cascadia subduction is constrained to around 50 Ma, which is consistent with yet providing a tighter timing constraint than previously reported (Hyndman et al., 1990; Stern and Dumitru, 2019). This work also refines existing models (Haeussler et al., 2003; Miller et al., 2023) and provides new constraints on the paleo-location of the Kula–Farallon–North American triple junction along the plate boundary since the late Cretaceous, capturing a main relocation around 40 Ma. A potential implication of this work is that the Juan de Fuca plate along the Cascadia margin formed in the Eocene as a microplate of the larger Farallon plate, similar to the modern Explorer microplate associated with the Juan de Fuca plate.

These findings advance our understanding of the tectonic evolution along the plate boundary of northwest North America, provide new constraints on plate interactions, timing, and geometry, and improve our interpretations of active structures, deformation, and seismic risk along the convergent margin. Nevertheless, more research is still needed to gain a better understanding, particularly regarding these aspects:

1. Additional thermochronological data, particularly ZHe, are needed for the central ranges of Vancouver Island and the Coast Mountains. These regions lack sufficient thermal constraints for the 150–250 °C range, which are crucial for explaining the pre-Eocene thermal evolution in response to tectonic configurations along the plate boundary.
2. Extending thermochronological studies to include mid-temperature systems is necessary to develop a comprehensive thermal and uplift history from the time of emplacement. Previous studies mainly compiled Ar/Ar and K/Ar ages but lack geological interpretation and data over 400 °C.
3. Further refinement of the recently established zircon Raman dating method is required. This work demonstrates that the current method cannot reliably con-

strain samples characterized by low radiation damage densities and long-term complex thermal histories, indicating a need for further calibration and potential to combine with other dating tools.

4. The accumulation of thermochronological data along the continental margins of the northwestern North American Plate can now enable a comprehensive integration of spatial exhumation patterns to elucidate the regional-scale response to tectonic evolution along the plate boundary.
5. Further investigation is needed to understand the generally old thermochronological ages observed on Vancouver Island, particularly the consistently old AHe ages relative to surrounding regions. Potential contributing factors may include the effects of glaciation and variations in regional crustal thickness.

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Appendix A

Chapter 2 Supplemental Material

A.1 Appendix A Tables

Table A.1: Single grain apatite (U-Th)/He data (AHe).

<i>Note:</i>
*Length is measured parallel to the c-axis and includes pyramidal terminations. It is measured three times on different sides.
†Width is measured perpendicular to the c-axis. It is measured three times on different sides.
§Geometry is defined as described as in Figure 3 of Ketcham et al. (2011). hp - hexagonal prism, c - cylinder, e - ellipsoid.
#Np denotes the number of terminations of the grain, including pyramidal or rounded shape.
**Blank-corrected ^4He , fmol = 10^{-15} mol
††Uncertainties on ^4He , U and Th are reported at 1σ standard deviation and include the total analytical uncertainties (TAU) .
§§Total blank-corrected ^{238}U and ^{235}U , assuming $^{235}\text{U} = ^{238}\text{U}/137.818$ after Hiess et al. (2012).
##Total blank-corrected ^{232}Th . ^{147}Sm can be negligible and is not measured in this study.
***Rs is the radius of a sphere with an equivalent alpha-ejection correction as the grain.
†††Mass is the mass of the crystal. Determined from the measured grain dimensions, the volume assuming the reported grain geometry, and the volume equations and mineral densities in Ketcham et al. (2011).
§§§Concentration of each element (He, U and Th) computed from the absolute amount of the measured isotopes and the estimated dimensional mass. $\mu\text{g/g}$ - micrograms per gram which is equivalent to parts per million.
####Uncertainties on U, Th and He concentrations are reported at 1σ and include the total analytical uncertainties (TAU).
****eU is effective uranium concentration. Calculated as $\text{U} + 0.238*\text{Th} + 0.0012*\text{Sm}$ after Appendix A of Cooperdock et al. (2019).
††††Uncertainty on eU is calculated as U uncertainty + $0.238*\text{Th}$ uncertainty
§§§§Th/U is the ratio of total U and Th concentrations
#####Uncorrected (U-Th)/He date is calculated iteratively using the He growth equation.
***** Uncertainty on the uncorrected and corrected (U-Th)/He date is reported at 1σ and includes the total analytical uncertainties (TAU).
†††††Alpha-ejection correction for the crystal is calculated using the proportion of U and Th contributing to ^4He production, and assuming homogeneous parent isotope distributions using Ketcham et al. (2011).
§§§§§Corrected date is calculated using the uncorrected date and the F_T correction factor.
#####Corrected ^4He is calculated using the blank-corrected ^4He and the F_T correction factor.
*****Corrected date 2 is calculated iteratively using the He growth equation with amounts of total U, Th and corrected ^4He
††††††N.D. = not determined. Geometry not determined is assumed to be hexagonal prism with 2 terminations in modelling.

Aliquot	Length 1 (μm)*	Width 1 (μm) [†]	Length 2 (μm)*	Width 2 (μm) [†]	Length 3 (μm)*	Width 3 (μm) [†]	Geometry [§]	Np [#]	4He (fmol)**	$\pm$ fmol (1 σ) ^{††}	U (fmol) ^{§§}	$\pm$ fmol (1 σ) ^{††}	Th (fmol) ^{##}	$\pm$ fmol (1 σ) ^{††}	Rs (μm)***	Mass (μg) ^{†††}
JL06-46-1	201.5	88.2	202.2	82.5	203.1	84.3	hp	1	2.11	0.03	69.84	1.79	148.57	2.84	46.8	2.7
JL06-46-2	106.7	83.4	101.3	75.1	106.0	80.4	hp	1	0.55	0.01	15.79	1.06	51.07	1.96	37.8	1.1
JL06-46-3	144.8	77.7	151.7	72.3	145.7	62.0	hp	0	0.67	0.01	21.06	0.80	73.22	2.60	37.9	1.3
JL06-46-4	148.6	74.2	143.9	64.6	151.0	66.3	hp	2	0.63	0.01	18.72	0.85	61.96	1.83	36.9	1.1
JL06-46-5	148.1	87.1	144.4	82.5	144.6	87.4	hp	2	0.70	0.01	33.67	1.39	77.24	2.85	43.2	1.5
JL06-46-6	139.4	82.7	147.5	70.6	141.4	79.2	hp	1	0.81	0.01	18.62	0.69	59.56	2.10	40.4	1.5
JL06-46-7	169.4	89.5	172.2	78.7	167.1	83.9	hp	1	1.46	0.02	43.65	1.97	117.73	3.17	44.8	2.13
JL06-46-8	118.6	81.5	117.5	75.6	103.9	67.6	N.D. ^{†††††}	N.D.	0.64	0.01	15.95	1.28	47.70	2.35	37.2	1.1
JL06-49-1	118.2	103.2	125.3	93.3	120.2	84.5	c	0	0.40	0.01	20.91	1.26	59.10	1.93	45.6	2.2
JL06-49-2	133.2	98.4	133.8	97.6	135.2	83.2	hp	2	1.25	0.02	23.60	0.68	52.47	2.02	45.5	1.9
JL06-49-3	150.6	77.4	138.2	80.9	134.0	83.8	hp	0	0.12	0.01	17.31	1.84	32.98	3.26	41.6	1.6
JL06-49-4	109.2	94.7	108.2	85.0	93.2	94.6	hp	0	0.22	0.01	9.89	1.10	29.07	1.34	42.9	1.8
JL06-49-5	109.2	71.3	109.4	70.0	111.0	66.9	hp	0	0.13	0.01	8.53	0.56	16.06	2.09	35.4	1.1
JL06-49-6	110.5	68.1	116.6	61.4	117.6	81.1	e	2	0.61	0.01	8.60	0.89	28.47	1.58	36.1	1.18
JL06-49-7	138.7	78.3	144.3	79.8	150.9	78.4	hp	0	0.27	0.01	11.39	1.14	44.06	3.21	41.4	1.87
JL06-49-8	125.6	63.1	122.1	64.8	119.1	64.2	hp	0	0.19	0.01	6.38	0.56	32.59	1.98	33.7	0.88
JL06-51-1	142.3	78.0	142.6	73.7	144.9	74.0	hp	2	1.21	0.02	53.99	1.77	116.53	2.40	39.3	1.2
JL06-51-2	135.5	82.8	162.7	84.5	148.4	84.6	c	0	2.36	0.03	49.36	1.04	89.12	2.05	43.9	2.2
JL06-51-3	134.8	73.4	134.4	72.6	138.7	72.5	hp	1	1.07	0.02	41.73	2.17	83.33	2.21	38.1	1.3
JL06-51-4	118.7	73.1	127.4	63.4	127.7	63.9	hp	0	0.65	0.01	23.40	1.47	47.11	1.44	35.2	1.2
JL06-51-5	100.9	76.6	106.8	77.9	105.3	74.0	c	0	0.62	0.01	26.03	1.14	89.83	2.00	36.6	0.1
JL06-51-6	112.5	76.4	117.7	72.0	123.5	75.1	hp	1	0.86	0.02	21.34	1.53	62.53	2.29	37.4	1.11
JL06-51-7	114	83.8	132.0	79.1	111.4	77.5	c	0	0.96	0.01	35.42	1.30	94.06	2.99	40.3	1.59
JL06-51-8	148.1	70.1	143.2	74.2	144.6	63.4	hp	2	2.01	0.03	77.34	1.77	142.64	2.77	37.1	1.05
JL06-56-1	114.9	82.5	116.4	79.6	114.9	65.8	hp	2	0.37	0.01	19.73	0.85	42.02	1.44	36.7	0.9
JL06-56-2	110.6	74.4	113.7	71.7	113.2	65.6	hp	1	0.87	0.01	14.89	0.65	50.92	1.95	35.5	1
JL06-56-3	104.8	73.0	105.6	73.8	106.4	73.8	hp	2	0.52	0.01	14.16	0.93	57.73	1.80	34.7	0.7
JL06-56-4	105.7	80.2	102.8	67.5	100.0	76.2	hp	1	0.39	0.01	16.22	0.81	41.91	1.39	36.0	0.9
JL06-56-5	119.8	66.1	117.2	61.9	115.7	66.4	hp	1	0.45	0.01	13.90	0.84	30.44	1.70	33.7	0.9
JL06-58-1	134.2	77.7	138.7	71.0	138.3	68.9	hp	1	0.43	0.01	13.59	0.71	46.49	1.77	38.1	1.3
JL06-58-2	126.9	94.2	122.5	72.7	121.8	84.5	hp	0	0.73	0.01	18.19	0.87	54.59	2.51	42.1	1.8
JL06-58-3	130.3	93.4	135.6	94.3	138.5	94.0	hp	1	0.54	0.01	17.14	1.23	49.08	1.74	45.9	2
JL06-58-4	127	84.0	126.2	69.3	141.5	69.3	hp	0	0.30	0.01	14.48	0.71	41.49	1.31	38.7	1.5
JL06-58-5	187.4	77.0	189.6	74.7	191.8	73.2	hp	2	0.60	0.01	22.04	1.25	67.30	1.89	41.8	1.7
JL06-64-1	105.3	64.4	107.6	62.5	106.5	65.8	hp	0	2.93	0.04	75.48	1.91	125.22	3.08	32.7	0.8
JL06-64-2	96.12	68.4	97.2	68.8	101.4	74.5	c	0	1.48	0.02	50.60	1.83	70.73	1.62	35.0	1.02
JL06-64-3	80.46	79.1	88.1	76.4	90.6	77.0	c	0	1.01	0.02	49.14	1.41	51.30	2.05	36.3	1.1
JL06-64-4	111.2	71.1	110.5	74.8	109.3	67.2	c	0	2.05	0.02	53.52	2.62	75.92	1.87	36.1	1.2
JL06-64-5	110	64.6	101.2	68.0	103.3	68.7	c	0	0.19	0.01	7.16	0.48	16.60	1.81	33.6	0.8
JL06-65-1	124.1	60.3	126.9	76.7	126.2	60.3	c	0	6.82	0.07	93.10	2.17	441.74	7.08	34.8	1.1
JL06-65-2	123.8	62.9	144.0	63.9	137.0	67.3	c	0	3.13	0.03	100.58	1.94	155.86	2.66	34.4	1
JL06-65-3	136	72.8	139.5	77.3	136.4	78.7	c	0	1.75	0.02	50.87	1.17	78.62	2.39	39.6	1.4
JL06-65-4	134.3	72.3	116.1	75.5	112.1	66.5	c	0	1.02	0.01	26.16	1.69	29.12	1.58	36.9	1.3
JL06-65-5	145.1	73.9	148.7	73.4	148.8	78.3	hp	1	3.04	0.03	111.91	2.81	152.27	4.50	39.6	1.2
JL06-70-1	162.6	84.9	167.3	89.7	163.9	70.2	hp	2	1.51	0.02	28.61	1.43	70.67	1.73	43.3	1.6
JL06-70-2	165.7	88.2	167.9	85.9	166.4	62.1	hp	2	0.91	0.02	26.18	1.07	70.58	2.32	42.3	1.6
JL06-70-3	134.9	89.0	140.9	98.8	139.6	95.9	hp	1	1.19	0.02	39.81	2.08	61.00	2.54	46.5	2.1
JL06-70-4	130.9	80.6	129.2	73.5	131.7	83.4	hp	1	1.12	0.02	24.77	1.29	54.97	2.94	40.2	1.4
JL06-70-5	163.3	91.0	175.3	92.8	169.2	80.2	hp	2	1.87	0.02	33.21	1.37	84.06	2.86	46.1	1.9

Aliquot	⁴ He (nmol/g) ^{\$\$\$}	± (1σ) ^{###}	[U] (μg/g) ^{\$\$\$}	± (1σ) ^{###}	[Th] (μg/g) ^{\$\$\$}	± (1σ) ^{###}	eU (μg/g) ^{****}	± (1σ) ⁺⁺⁺⁺	Th/U ^{\$\$\$\$}	Uncorr Date (Ma) ^{###}	± (1σ) ^{*****}	F _T ⁺⁺⁺⁺	Corr Date (Ma) ^{\$\$\$\$\$}	± (1σ, ABS) ^{*****}	Corr ⁴ He (fmol) ^{####}	Corr Date_2 (Ma) ^{*****}
JL06-46-1	0.78	0.01	6.16	0.16	12.77	0.24	9.19	0.16	2.1	15.78	0.35	0.72	21.92	0.49	2.93	21.90
JL06-46-2	0.50	0.01	3.42	0.23	10.77	0.41	5.98	0.24	3.2	15.54	0.71	0.678	22.92	1.05	0.81	22.92
JL06-46-3	0.52	0.01	3.86	0.15	13.07	0.46	6.97	0.16	3.5	13.80	0.42	0.657	21.00	0.64	1.02	21.00
JL06-46-4	0.57	0.01	4.05	0.18	13.07	0.39	7.16	0.19	3.3	14.87	0.53	0.614	24.22	0.86	1.03	24.21
JL06-46-5	0.47	0.01	5.34	0.22	11.95	0.44	8.19	0.23	2.3	10.61	0.36	0.672	15.79	0.54	1.04	15.79
JL06-46-6	0.54	0.01	2.95	0.11	9.21	0.32	5.15	0.12	3.2	19.40	0.60	0.682	28.45	0.88	1.18	28.43
JL06-46-7	0.68	0.01	4.88	0.22	12.82	0.34	7.93	0.23	2.7	16.03	0.53	0.71	22.58	0.75	2.05	22.58
JL06-46-8	0.58	0.01	3.45	0.28	10.06	0.49	5.85	0.29	3.0	18.44	0.99	0.674	27.36	1.47	0.95	27.34
JL06-49-1	0.18	0.00	2.26	0.14	6.23	0.20	3.75	0.14	2.8	9.04	0.40	0.759	11.91	0.53	0.53	11.91
JL06-49-2	0.66	0.01	2.96	0.08	6.41	0.25	4.48	0.09	2.2	27.23	0.71	0.729	37.35	0.97	1.72	37.35
JL06-49-3	0.08	0.01	2.57	0.27	4.78	0.47	3.71	0.29	1.9	3.81	0.40	0.7	5.44	0.57	0.17	5.44
JL06-49-4	0.12	0.01	1.31	0.15	3.75	0.17	2.20	0.15	2.9	10.45	0.85	0.753	13.88	1.13	0.30	13.88
JL06-49-5	0.12	0.01	1.85	0.12	3.39	0.44	2.65	0.13	1.9	8.06	0.70	0.684	11.78	1.02	0.19	11.78
JL06-49-6	0.51	0.01	1.73	0.18	5.60	0.31	3.07	0.19	3.3	31.06	2.04	0.68	45.68	3.00	0.89	45.67
JL06-49-7	0.15	0.00	1.45	0.15	5.47	0.40	2.75	0.16	3.9	9.91	0.70	0.659	15.04	1.06	0.42	15.03
JL06-49-8	0.22	0.01	1.73	0.15	8.59	0.52	3.77	0.16	5.1	10.81	0.80	0.616	17.55	1.30	0.31	17.54
JL06-51-1	1.01	0.01	10.71	0.35	22.53	0.46	16.07	0.36	2.2	11.65	0.31	0.641	18.17	0.48	1.89	18.17
JL06-51-2	1.07	0.01	5.34	0.11	9.40	0.22	7.58	0.12	1.8	26.21	0.54	0.737	35.56	0.73	3.20	35.55
JL06-51-3	0.82	0.01	7.64	0.40	14.87	0.39	11.18	0.41	2.0	13.67	0.55	0.669	20.43	0.82	1.60	20.43
JL06-51-4	0.54	0.01	4.64	0.29	9.11	0.28	6.81	0.30	2.0	14.80	0.70	0.671	22.06	1.04	0.97	22.05
JL06-51-5	6.21	0.13	61.96	2.72	208.41	4.64	111.56	2.83	3.5	10.35	0.35	0.665	15.56	0.53	0.93	15.55
JL06-51-6	0.77	0.01	4.58	0.33	13.07	0.48	7.69	0.34	2.9	18.64	0.91	0.666	27.99	1.37	1.29	27.97
JL06-51-7	0.60	0.01	5.30	0.19	13.73	0.44	8.57	0.20	2.7	13.06	0.38	0.72	18.14	0.53	1.33	18.13
JL06-51-8	1.92	0.02	17.53	0.40	31.52	0.61	25.03	0.41	1.8	14.21	0.30	0.625	22.74	0.48	3.22	22.72
JL06-56-1	0.42	0.01	5.22	0.23	10.83	0.37	7.80	0.23	2.1	9.89	0.43	0.62	15.95	0.69	0.60	15.95
JL06-56-2	0.87	0.01	3.54	0.15	11.81	0.45	6.36	0.17	3.4	25.28	0.83	0.648	39.01	1.28	1.34	39.00
JL06-56-3	0.75	0.01	4.81	0.32	19.13	0.60	9.37	0.33	4.1	14.80	0.62	0.591	25.04	1.05	0.88	25.03
JL06-56-4	0.44	0.01	4.29	0.21	10.80	0.36	6.86	0.22	2.6	11.82	0.47	0.662	17.85	0.71	0.59	17.86
JL06-56-5	0.50	0.01	3.68	0.22	7.85	0.44	5.54	0.23	2.2	16.68	0.81	0.63	26.48	1.29	0.71	26.48
JL06-58-1	0.33	0.01	2.49	0.13	8.30	0.32	4.46	0.14	3.4	13.89	0.58	0.663	20.95	0.87	0.65	20.94
JL06-58-2	0.41	0.01	2.40	0.12	7.04	0.32	4.08	0.12	3.0	18.46	0.70	0.731	25.25	0.96	1.00	25.26
JL06-58-3	0.27	0.01	2.04	0.15	5.69	0.20	3.39	0.15	2.9	14.65	0.73	0.728	20.12	1.00	0.74	20.12
JL06-58-4	0.20	0.01	2.30	0.11	6.42	0.20	3.82	0.12	2.9	9.60	0.43	0.699	13.73	0.62	0.42	13.73
JL06-58-5	0.35	0.01	3.09	0.18	9.18	0.26	5.27	0.18	3.1	12.50	0.51	0.657	19.03	0.78	0.92	19.03
JL06-64-1	3.66	0.05	22.46	0.57	36.31	0.89	31.10	0.59	1.7	21.86	0.51	0.627	34.86	0.81	4.68	34.82
JL06-64-2	1.45	0.02	11.81	0.43	16.09	0.37	15.63	0.44	1.4	17.16	0.54	0.691	24.83	0.78	2.14	24.83
JL06-64-3	0.92	0.02	10.63	0.31	10.82	0.43	13.21	0.32	1.0	12.92	0.39	0.721	17.92	0.54	1.40	17.92
JL06-64-4	1.71	0.02	10.62	0.52	14.68	0.36	14.11	0.53	1.4	22.46	0.88	0.694	32.36	1.27	2.95	32.35
JL06-64-5	0.23	0.01	2.13	0.14	4.81	0.53	3.28	0.15	2.3	13.13	0.92	0.635	20.68	1.45	0.29	20.67
JL06-65-1	6.20	0.06	20.14	0.47	93.17	1.49	42.32	0.51	4.7	27.18	0.47	0.656	41.43	0.72	10.39	41.40
JL06-65-2	3.13	0.03	23.94	0.46	36.16	0.62	32.54	0.48	1.5	17.86	0.33	0.635	28.13	0.52	4.93	28.10
JL06-65-3	1.25	0.02	8.65	0.20	13.03	0.40	11.75	0.21	1.5	19.77	0.44	0.685	28.86	0.64	2.56	28.85
JL06-65-4	0.78	0.01	4.79	0.31	5.20	0.28	6.03	0.32	1.1	24.13	1.30	0.697	34.62	1.87	1.46	34.61
JL06-65-5	2.54	0.03	22.20	0.56	29.44	0.87	29.20	0.58	1.4	16.12	0.38	0.649	24.84	0.59	4.69	24.82
JL06-70-1	0.94	0.01	4.26	0.21	10.25	0.25	6.69	0.22	2.5	26.17	0.93	0.67	39.06	1.39	2.26	39.02
JL06-70-2	0.57	0.01	3.89	0.16	10.23	0.34	6.33	0.17	2.7	16.70	0.55	0.662	25.23	0.83	1.38	25.23
JL06-70-3	0.56	0.01	4.51	0.24	6.74	0.28	6.12	0.24	1.5	17.13	0.74	0.737	23.24	1.00	1.61	23.25
JL06-70-4	0.80	0.01	4.21	0.22	9.11	0.49	6.38	0.23	2.2	23.30	0.96	0.691	33.72	1.39	1.62	33.71
JL06-70-5	0.98	0.01	4.16	0.17	10.26	0.35	6.60	0.18	2.5	27.57	0.87	0.69	39.96	1.26	2.70	39.93

Aliquot	Length 1 (μm)*	Width 1 (μm) [†]	Length 2 (μm)*	Width 2 (μm) [†]	Length 3 (μm)*	Width 3 (μm) [†]	Geometry [§]	Np [#]	4He (fmol)**	$\pm$ fmol (1 σ) ^{††}	U (fmol) ^{§§}	$\pm$ fmol (1 σ) ^{††}	Th (fmol) ^{##}	$\pm$ fmol (1 σ) ^{††}	Rs (μm)***	Mass (μg) ^{†††}
JL06-73-1	124.1	74.1	124.6	72.2	121.4	63.4	hp	1	1.15	0.02	41.77	1.92	140.51	5.05	36.1	1.1
JL06-73-2	116.4	97.5	120.2	94.1	114.8	97.3	hp	1	5.05	0.05	82.45	1.65	292.07	6.15	44.4	1.7
JL06-73-3	121.8	80.6	120.9	78.1	121.9	83.6	hp	1	1.18	0.02	41.34	1.54	56.29	2.31	38.9	1
JL06-73-4	168.7	95.4	176.7	92.8	162.2	90.6	hp	1	2.81	0.03	63.04	2.14	199.89	4.55	48.4	2.6
JL06-73-5	128.9	100.0	140.5	79.5	131.8	82.3	hp	2	2.54	0.03	56.93	1.80	165.50	4.46	42.3	1.3
JL06-90-1	143.3	113.5	142.0	93.2	139.2	107.7	hp	1	3.48	0.04	59.59	2.60	140.73	3.78	50.2	2.5
JL06-90-2	163.4	106.2	164.3	94.2	159.4	108.7	hp	1	3.36	0.04	58.36	1.76	170.91	5.63	51.7	2.9
JL06-90-3	133.6	89.2	136.1	82.9	132.5	83.3	hp	2	1.38	0.02	31.99	1.24	70.60	2.56	41.8	1.3
JL06-90-4	171.1	109.0	167.6	98.9	167.9	100.1	hp	2	3.65	0.04	74.53	2.19	194.45	5.77	51.1	2.4
JL06-90-5	154.5	91.1	152.3	76.0	151.4	77.3	hp	2	1.87	0.02	40.79	1.54	100.34	4.03	42.3	1.5
DC06-61-1	127.7	67.4	127.5	61.9	129.9	63.9	hp	2	1.43	0.02	34.71	1.43	79.69	1.67	34.0	0.8
DC06-61-2	109.5	76.5	104.3	72.8	106.4	73.3	hp	0	26.07	0.27	766.00	13.49	790.23	13.19	37.0	1.2
DC06-61-3	85.34	79.0	87.1	72.3	85.1	81.6	hp	1	1.01	0.02	26.63	1.04	58.05	2.95	34.5	0.8
DC06-61-5	171.7	97.0	171.8	95.4	156.3	93.7	hp	1	3.48	0.04	109.71	2.58	244.97	5.50	49.2	2.6
DC06-62-1	112.9	81.7	111.3	64.5	113.3	79.5	hp	2	1.23	0.02	50.24	1.42	78.85	2.27	36.1	0.8
DC06-62-2	154.2	90.7	154.6	82.2	153.5	70.3	hp	2	1.75	0.02	57.76	1.75	137.49	2.67	42.3	1.5
DC06-62-3	123.5	82.2	128.7	70.5	126.3	80.3	hp	1	1.80	0.02	57.70	2.00	144.89	4.02	39.3	1.3
DC06-62-4	100	70.1	99.6	62.4	101.7	65.4	hp	1	0.69	0.01	27.31	1.37	51.63	2.98	32.8	0.7
DC06-62-5	117	87.5	115.8	86.6	121.3	82.2	hp	2	2.15	0.02	72.09	1.40	153.52	4.38	39.5	1
VI2001-1	117.3	89.3	115.7	89.5	116.5	96.5	hp	1	1.14	0.02	30.33	2.03	57.39	1.69	40.6	1.11
VI2001-2	166	97.6	166.9	93.9	166.6	85.8	hp	2	1.72	0.02	39.36	0.96	74.78	1.42	47.5	2.01
VI2001-3	169.4	104.0	166.2	96.2	176.9	95.6	hp	2	1.66	0.02	32.31	0.99	101.34	2.44	50.7	2.88
VI2001-4	117.7	83.4	117.9	83.6	115.8	77.5	hp	1	0.80	0.01	19.50	1.18	52.25	2.45	39.8	1.29
VI2001-5	170.7	71.4	170.7	66.2	171.4	62.2	hp	2	0.95	0.02	19.05	1.15	43.24	1.31	37.2	1.22
VI2002-1	103.9	72.2	111.3	66.5	108.2	69.9	c	0	0.64	0.01	13.00	0.66	30.80	1.61	35.3	1.08
VI2002-2	110.5	84.9	101.6	80.5	110.3	82.5	c	0	1.02	0.01	17.40	1.01	74.62	3.05	40.3	1.52
VI2002-3	139.7	69.8	132.9	72.7	134.9	76.1	c	0	1.37	0.02	24.84	1.39	64.95	2.33	38.4	1.5
VI2002-5	95.07	67.3	87.7	61.2	93.8	61.3	c	0	0.53	0.01	7.93	0.81	42.05	1.95	31.6	0.77
VI2003-1	184.8	84.9	193.4	89.2	199.2	73.7	hp	1	3.64	0.04	83.01	1.89	125.32	2.62	45.3	2.39
VI2003-2	146.8	85.3	148.5	87.7	144.9	79.1	hp	0	4.49	0.05	154.99	2.82	239.15	4.15	43.3	1.8
VI2003-3	160.9	91.6	153.1	93.1	152.9	88.3	hp	0	4.04	0.04	105.06	4.03	121.17	3.14	47.2	2.68
VI2003-5	128.1	63.8	127.8	66.8	127.5	62.1	hp	0	2.21	0.03	56.52	2.02	78.87	2.09	34.2	1.1
VI2003-6	121.7	74.8	126.4	75.4	116.0	76.5	hp	0	2.90	0.04	77.10	2.51	91.59	1.86	38.7	1.44
VI2003-7	170.5	81.1	169.9	83.6	167.9	78.8	hp	0	4.43	0.05	132.35	3.28	143.50	3.47	43.4	1.68
VI2003-8	200.6	76.8	199.1	78.4	198.2	79.4	hp	0	4.23	0.05	94.77	4.22	134.67	2.22	43.5	2.25
VI2004-1	94.4	85.3	100.0	84.9	88.9	87.7	hp	0	3.45	0.04	63.54	1.99	156.46	3.31	40.1	1.5
VI2004-2	114.8	88.4	118.7	87.3	114.0	84.4	c	0	1.11	0.02	25.71	1.37	10.00	1.59	41.3	1.4
VI2004-3	95.84	71.5	105.8	66.0	98.1	64.0	hp	1	0.47	0.01	13.19	0.62	20.04	2.92	33.2	0.8
VI2004-4	100.7	73.8	99.1	63.2	98.3	72.5	c	0	2.12	0.03	40.00	1.63	126.16	3.70	34.8	1
VI2004-5	99.29	72.7	96.8	54.5	98.5	69.8	c	0	1.30	0.02	36.13	1.25	43.25	2.05	32.5	0.7
VI2004-6	129.1	72.4	121.1	61.6	117.4	57.8	hp	1	0.46	0.01	9.93	0.83	15.79	2.47	33.9	1.04
VI2004-7	103.9	90.5	100.9	99.6	N.D.	N.D.	c	0	4.33	0.05	102.40	2.78	156.36	3.55	44.0	1.92
VI2004-8	108.6	67.1	110.2	68.1	108.5	68.9	e	2	2.52	0.03	59.20	1.98	102.13	2.33	34.8	1.05

Aliquot	^4He (nmol/g) ^{§§§}	$\pm (1\sigma)^{###}$	[U] ($\mu\text{g/g}$) ^{§§§}	$\pm (1\sigma)^{###}$	[Th] ($\mu\text{g/g}$) ^{§§§}	$\pm (1\sigma)^{###}$	eU ($\mu\text{g/g}$) ^{****}	$\pm (1\sigma)^{++++}$	Th/U ^{§§§§}	Uncorr Date (Ma) ^{####}	$\pm (1\sigma)^{*****}$	F _T ⁺⁺⁺⁺	Corr Date (Ma) ^{§§§§§}	$\pm (1\sigma, \text{ABS})^{*****}$	Corr ^4He (fmol) ^{####}	Corr Date_2 (Ma) ^{*****}
JL06-73-1	1.05	0.01	9.04	0.41	29.64	1.06	16.09	0.44	3.4	12.12	0.40	0.65	18.65	0.62	1.78	18.63
JL06-73-2	2.97	0.03	11.54	0.23	39.86	0.84	21.03	0.25	3.5	26.20	0.47	0.725	36.14	0.65	6.96	36.11
JL06-73-3	1.18	0.02	9.84	0.37	13.06	0.53	12.95	0.38	1.4	16.98	0.57	0.644	26.37	0.89	1.84	26.35
JL06-73-4	1.08	0.01	5.77	0.20	17.84	0.41	10.02	0.21	3.2	20.01	0.50	0.733	27.30	0.68	3.83	27.29
JL06-73-5	1.96	0.02	10.42	0.33	29.53	0.80	17.45	0.35	2.9	20.80	0.51	0.662	31.42	0.77	3.84	31.40
JL06-90-1	1.39	0.02	5.67	0.25	13.06	0.35	8.78	0.26	2.4	29.39	0.93	0.754	38.98	1.23	4.61	38.95
JL06-90-2	1.16	0.01	4.79	0.14	13.67	0.45	8.04	0.16	2.9	26.69	0.67	0.755	35.35	0.89	4.44	35.33
JL06-90-3	1.06	0.02	5.86	0.23	12.60	0.46	8.86	0.24	2.2	22.27	0.71	0.662	33.64	1.07	2.09	33.63
JL06-90-4	1.52	0.02	7.39	0.22	18.80	0.56	11.86	0.23	2.6	23.76	0.58	0.718	33.09	0.81	5.08	33.07
JL06-90-5	1.25	0.02	6.47	0.24	15.52	0.62	10.17	0.26	2.5	22.73	0.70	0.664	34.23	1.05	2.81	34.21
DC06-61-1	1.78	0.02	10.33	0.43	23.11	0.48	15.83	0.44	2.3	20.90	0.64	0.592	35.30	1.08	2.41	35.29
DC06-61-2	21.72	0.22	151.92	2.68	152.78	2.55	188.28	2.74	1.0	21.39	0.38	0.708	30.21	0.54	36.82	30.20
DC06-61-3	1.26	0.02	7.92	0.31	16.83	0.85	11.93	0.33	2.2	19.64	0.68	0.664	29.58	1.02	1.52	29.56
DC06-61-5	1.34	0.02	10.04	0.24	21.86	0.49	15.24	0.25	2.2	16.29	0.34	0.742	21.95	0.46	4.69	21.95
DC06-62-1	1.54	0.03	14.95	0.42	22.87	0.66	20.39	0.44	1.6	14.02	0.39	0.618	22.69	0.63	1.99	22.69
DC06-62-2	1.17	0.02	9.16	0.28	21.27	0.41	14.22	0.29	2.4	15.23	0.38	0.664	22.94	0.57	2.64	22.93
DC06-62-3	1.39	0.02	10.56	0.37	25.86	0.72	16.72	0.38	2.5	15.39	0.43	0.682	22.57	0.63	2.64	22.55
DC06-62-4	0.98	0.02	9.29	0.47	17.11	0.99	13.36	0.49	1.9	13.67	0.60	0.631	21.66	0.95	1.09	21.66
DC06-62-5	2.15	0.02	17.16	0.33	35.62	1.02	25.63	0.36	2.1	15.54	0.31	0.645	24.09	0.48	3.33	24.08
VI2001-1	1.03	0.02	6.50	0.43	12.00	0.35	9.36	0.44	1.9	20.37	1.01	0.654	31.15	1.54	1.74	31.12
VI2001-2	0.86	0.01	4.66	0.11	8.63	0.16	6.71	0.12	1.9	23.69	0.54	0.701	33.79	0.77	2.46	33.79
VI2001-3	0.58	0.01	2.67	0.08	8.16	0.20	4.61	0.09	3.1	23.22	0.56	0.746	31.13	0.75	2.23	31.11
VI2001-4	0.62	0.01	3.60	0.22	9.40	0.44	5.83	0.23	2.7	19.80	0.89	0.649	30.51	1.37	1.24	30.49
VI2001-5	0.78	0.01	3.72	0.22	8.22	0.25	5.67	0.23	2.3	25.44	1.14	0.623	40.83	1.83	1.52	40.80
VI2002-1	0.60	0.01	2.87	0.14	6.62	0.34	4.44	0.15	2.4	24.95	1.03	0.682	36.58	1.51	0.95	36.57
VI2002-2	0.67	0.01	2.72	0.16	11.39	0.47	5.44	0.17	4.3	22.99	0.88	0.651	35.31	1.35	1.57	35.30
VI2002-3	0.91	0.01	3.94	0.22	10.05	0.36	6.33	0.23	2.6	26.69	1.06	0.695	38.40	1.53	1.97	38.37
VI2002-5	0.68	0.01	2.45	0.25	12.67	0.59	5.47	0.26	5.3	23.23	1.29	0.641	36.24	2.01	0.82	36.22
VI2003-1	1.52	0.02	8.27	0.19	12.16	0.25	11.16	0.19	1.5	25.28	0.53	0.715	35.36	0.74	5.09	35.33
VI2003-2	2.49	0.03	20.49	0.37	30.82	0.54	27.83	0.39	1.5	16.62	0.29	0.682	24.37	0.43	6.58	24.36
VI2003-3	1.51	0.02	9.33	0.36	10.49	0.27	11.83	0.36	1.2	23.66	0.77	0.759	31.17	1.01	5.33	31.16
VI2003-5	2.01	0.02	12.23	0.44	16.64	0.44	16.19	0.45	1.4	23.06	0.70	0.663	34.78	1.06	3.34	34.75
VI2003-6	2.01	0.03	12.74	0.41	14.76	0.30	16.25	0.42	1.2	22.98	0.66	0.652	35.25	1.01	4.45	35.21
VI2003-7	2.63	0.03	18.75	0.46	19.82	0.48	23.47	0.48	1.1	20.82	0.48	0.68	30.62	0.71	6.51	30.59
VI2003-8	1.88	0.02	10.02	0.45	13.89	0.23	13.33	0.45	1.4	26.17	0.94	0.702	37.28	1.34	6.03	37.25
VI2004-1	2.30	0.03	10.08	0.32	24.20	0.51	15.84	0.33	2.5	26.94	0.65	0.739	36.45	0.88	4.67	36.43
VI2004-2	0.79	0.01	4.37	0.23	1.66	0.26	4.76	0.24	0.4	30.87	1.63	0.717	43.05	2.27	1.55	43.01
VI2004-3	0.58	0.01	3.92	0.18	5.81	0.85	5.31	0.20	1.5	20.38	1.15	0.639	31.89	1.80	0.73	31.88
VI2004-4	2.12	0.03	9.52	0.39	29.27	0.86	16.49	0.41	3.2	23.83	0.71	0.68	35.04	1.04	3.11	35.02
VI2004-5	1.86	0.03	12.29	0.42	14.33	0.68	15.70	0.44	1.2	21.95	0.70	0.633	34.68	1.11	2.05	34.65
VI2004-6	0.45	0.01	2.27	0.19	3.52	0.55	3.11	0.20	1.6	26.58	2.03	0.661	40.21	3.07	0.70	40.20
VI2004-7	2.26	0.03	12.69	0.34	18.89	0.43	17.19	0.35	1.5	24.33	0.58	0.767	31.72	0.76	5.65	31.70
VI2004-8	2.40	0.03	13.42	0.45	22.57	0.52	18.79	0.46	1.7	23.69	0.65	0.679	34.89	0.96	3.71	34.86

Table A.2: Summary of apatite fission track results (AFT) for individual samples.

SAMPLE: JL06-46							
Table S2:							
Grain #	Ns	Area (μm^2)	238U ($\mu\text{g/g}$)	238U lse ($\mu\text{g/g}$)	Age (Ma)	Age lse (Ma)	Dpar (μm)
6.JL-46-02	15	10995.68	4.55	0.12	57.64	14.96	1.8
7.JL-46-03	9	9996.3	5.01	0.14	34.61	11.58	2.06
8.JL-46-04	9	6371.8	4.74	0.12	57.29	19.15	1.97
9.JL-46-05	11	7041.09	4.14	0.1	72.46	21.92	1.89
12.JL-46-06	10	9940.92	4.26	0.13	45.44	14.44	1.61
13.JL-46-07	9	5487.4	4.49	0.13	70.15	23.47	1.73
14.JL-46-08	23	9302.62	3.74	0.1	126.4	26.57	1.75
15.JL-46-09	5	7813.49	4.58	0.11	26.92	12.06	2.28
16.JL-46-10	13	8911.27	5.69	0.14	49.32	13.73	1.93
19.JL-46-11	10	9509.5	5.34	0.11	37.91	12.01	2.31
20.JL-46-12	14	7056.4	5.44	0.13	70.04	18.79	1.91
21.JL-46-13	7	5286.36	3.58	0.1	71.03	26.92	2.17
22.JL-46-14	7	4677.39	4.65	0.15	61.85	23.46	1.65
23.JL-46-15	9	9719.4	4.04	0.1	44.11	14.74	1.66
26.JL-46-16	10	8577.97	3.19	0.11	70.18	22.33	1.97
27.JL-46-17	8	5151.27	4.32	0.11	69.05	24.47	2.02
28.JL-46-18	13	8703.88	3.58	0.09	80.06	22.3	2.06
29.JL-46-19	7	8754.92	4.57	0.13	33.7	12.77	1.78
30.JL-46-20	9	7716.67	4.16	0.1	53.91	18.02	1.92
34.JL-46-22	7	2940.57	5.52	0.12	82.74	31.32	2.02
35.JL-46-23	6	5100.68	4.69	0.11	48.25	19.73	1.7
36.JL-46-24	8	3532	3.88	0.1	111.75	39.61	2.01
37.JL-46-25	4	6012.69	4.12	0.09	31.1	15.57	2.04
40.JL-46-26	11	11400.44	4.51	0.12	41.18	12.46	1.91
41.JL-46-27	11	8156.74	4.48	0.11	57.87	17.51	2.22
42.JL-46-28	9	6990.44	4.64	0.14	53.36	17.86	1.96
43.JL-46-29	10	6555.41	4.02	0.13	72.86	23.16	2.07
44.JL-46-30	7	4192.18	4.42	0.11	72.54	27.48	2.02
47.JL-46-31	10	6317.61	4.22	0.1	72.02	22.84	2.18
48.JL-46-32	7	6660.51	4.35	0.1	46.48	17.6	2.14
49.JL-46-33	6	3560.45	5.07	0.12	63.86	26.12	1.9
50.JL-46-34	7	4540.39	4.38	0.1	67.61	25.6	1.77
51.JL-46-35	7	5606.52	4.82	0.13	49.83	18.88	1.99
52.JL-46-36	4	5285.17	4.45	0.11	32.76	16.4	2.29
<i>Note:</i>							
N _s – number of spontaneous tracks							
Area – area of interest of grain							
Dpar – fission track etch pit diameter parallel to c-axis							
lse – 1 sigma standard error							
$\mu\text{g/g}$ – micrograms per gram which is equivalent to parts per million							

SAMPLE: JL06-49							
Table S2:							
Grain #	Ns	Area (μm^2)	238U ($\mu\text{g/g}$)	238U lse ($\mu\text{g/g}$)	Age (Ma)	Age lse (Ma)	Dpar (μm)
5.JL-49-01	5	5413.70	2.79	0.12	63.61	28.58	1.46
6.JL-49-02	4	2978.29	3.05	0.13	84.47	42.39	2.12
7.JL-49-03	3	3667.06	3.63	0.12	43.37	25.08	2.42
8.JL-49-05	3	3640.66	3.15	0.12	50.32	29.11	1.93
9.JL-49-06	5	3421.83	3.24	0.17	86.50	38.95	1.87
12.JL-49-07	3	3429.13	2.83	0.10	59.42	34.37	1.53
13.JL-49-08	4	1230.76	2.66	0.09	231.71	116.12	1.47
14.JL-49-09	4	2361.97	3.55	0.18	91.46	45.97	1.81
15.JL-49-10	4	2059.25	3.75	0.14	99.25	49.77	1.48
16.JL-49-11	5	1921.38	3.24	0.13	153.26	68.81	1.67
19.JL-49-12	24	1261.54	48.92	0.94	74.66	15.31	1.79
20.JL-49-13	3	1529.13	3.28	0.16	114.48	66.33	1.45
21.JL-49-14	4	2621.54	2.85	0.10	102.56	51.41	2.01

SAMPLE: JL06-56							
Table S2:							
Grain #	Ns	Area (μm^2)	238U ($\mu\text{g/g}$)	238U 1se ($\mu\text{g/g}$)	Age (Ma)	Age 1se (Ma)	Dpar (μm)
5.JL-56-01	4	2559.75	3.25	0.08	92.18	46.15	1.71
7.JL-56-03	2	1479.45	4.37	0.12	59.46	42.08	1.85
8.JL-56-04	6	3199.46	4.66	0.14	77.24	31.62	1.36
9.JL-56-05	2	1101.76	4.35	0.11	80.08	56.66	1.54
13.JL-56-07	3	2305.78	3.63	0.08	68.84	39.77	2.04
14.JL-56-08	3	2665.6	4.57	0.1	47.38	27.37	2.01
15.JL-56-09	3	1939.02	4.61	0.13	64.48	37.27	1.49
16.JL-56-10	5	3405.35	5.3	0.12	53.27	23.86	1.56
20.JL-56-12	3	1898.62	3.77	0.12	80.43	46.51	2.01
21.JL-56-13	2	2829.11	3.46	0.08	39.33	27.83	2.04
22.JL-56-14	2	2255.88	3.96	0.09	43.09	30.48	1.45
23.JL-56-15	7	2256.08	3.6	0.08	164.31	62.21	1.93
27.JL-56-17	4	2848.59	3.77	0.11	71.52	35.82	1.85
29.JL-56-19	3	1735.1	4.6	0.11	72.17	41.71	1.8
30.JL-56-20	4	2197.59	5.28	0.1	66.23	33.14	1.49
33.JL-56-21	3	2209.72	4.94	0.16	52.85	30.56	1.66
34.JL-56-22	3	2439.29	4.6	0.11	51.42	29.71	1.68
35.JL-56-23	5	3582.86	3.81	0.13	70.34	31.55	1.52
36.JL-56-24	5	3366.58	3.76	0.1	75.83	33.97	1.45
37.JL-56-25	4	2897.01	4.58	0.12	57.95	29.02	1.92
40.JL-56-27	5	2734.03	3.63	0.08	96.56	43.23	1.94
41.JL-56-28	3	2707.43	3.75	0.1	56.81	32.83	1.8
42.JL-56-29	4	2044.16	4.86	0.14	77.28	38.71	1.78
43.JL-56-30	3	2531.88	5.39	0.12	42.31	24.45	1.53
44.JL-56-31	5	2095.39	5.8	0.13	78.96	35.35	1.17
45.JL-56-32	4	2804	3.81	0.13	71.9	36.03	1.75
*JL-56-15 is deleted in thermal modelling as the only one outlier							

SAMPLE: JL06-58								SAMPLE: JL06-64									
Table S2:								Table S2:									
Grain #	Ns	Area (µm²)	238U (µg/g)	238U 1se (µg/g)	Age (Ma)	Age 1se (Ma)	Dpar (µm)	Grain #	Ns	Area (µm²)	238U (µg/g)	238U 1se (µg/g)	238U-2 (µg/g)	238U-2 1se (µg/g)	Age (Ma)	Age 1se (Ma)	Dpar (µm)
5.JL-58-01	7	6194.19	3.05	0.14	71.15	27.09	2.24	7.JL-64-03	6	1696.66	28.93	0.39			23.56	9.66	1.27
6.JL-58-02	6	5358.19	2.32	0.18	92.53	38.45	1.81	9.JL-64-06	9	4007.31	20.53	0.50	18.44	0.43	22.25	7.47	1.48
7.JL-58-03	8	5086.65	6.54	0.3	46.27	16.5	1.69	13.JL-64-07	5	1455.86	18.18	0.49			36.38	16.32	1.53
9.JL-58-05	4	3630.7	2.79	0.14	75.8	38.09	2.07	14.JL-64-08	9	1280.01	53.63	1.27			25.27	8.46	1.43
12.JL-58-06	8	4012.73	2.67	0.12	142.59	50.82	2.05	15.JL-64-09	4	2492.51	23.22	0.60			13.33	6.69	1.50
13.JL-58-07	5	3137.74	2.51	0.1	121.44	54.52	2.01	16.JL-64-10	11	3817.36	24.56	0.66			22.62	6.91	1.58
14.JL-58-08	7	8288.71	3.42	0.13	47.51	18.05	2.13	20.JL-64-11	5	1828.56	30.73	0.74			17.16	7.70	1.67
16.JL-58-10	4	9128.22	2.25	0.11	37.5	18.84	2.2	21.JL-64-12	8	2307.66	22.78	0.56			29.32	10.44	1.67
20.JL-58-12	8	4637.63	4.02	0.15	82.33	29.27	2.26	22.JL-64-13	10	2551.61	31.53	0.83			23.96	7.65	1.43
21.JL-58-13	4	8200.94	2.45	0.12	38.33	19.26	2.2	24.JL-64-16	4	2939.37	7.86	0.16			33.35	16.75	1.51
22.JL-58-14	4	3585.46	2.86	0.11	74.89	37.55	2.04	29.JL-64-18	7	2440.77	51.71	1.23			10.70	4.07	1.59
23.JL-58-15	3	3624.74	2.3	0.11	69.11	40.04	2.25	30.JL-64-19	7	2050.32	16.99	0.40			38.69	14.71	1.48
26.JL-58-16	4	3856.45	2.58	0.13	77.17	38.78	2.09	31.JL-64-20	10	2825.37	21.67	0.67			31.46	10.06	1.51
27.JL-58-17	4	2435.31	2.36	0.11	133.01	66.79	2.77	34.JL-64-21	7	3753.89	27.78	0.69	28.20	0.73	12.85	4.88	1.49
28.JL-58-18	5	9207.6	2.99	0.12	34.97	15.7	2.02	36.JL-64-22	21	5599.93	37.93	0.99	34.71	0.91	19.93	4.45	1.56
29.JL-58-19	4	3185.15	2.29	0.11	105.03	52.76	1.78	38.JL-64-23	17	1633.37	46.89	1.34			42.72	10.48	1.63
30.JL-58-20	8	7560.29	3.41	0.14	59.64	21.23	1.8	41.JL-64-24	8	1905.20	42.47	1.14			19.06	6.78	1.41
33.JL-58-21	4	2757.85	3.17	0.13	87.75	44.02	2.16	42.JL-64-25	6	1508.08	30.76	0.76			24.93	10.21	1.37
34.JL-58-22	7	6428.15	2.67	0.15	78.28	29.91	1.81	44.JL-64-27	8	1727.42	27.00	0.70			33.04	11.75	1.57
35.JL-58-23	4	5019.21	2.23	0.08	68.64	34.41	1.93	45.JL-64-28	4	2173.32	22.00	0.59			16.13	8.10	1.38
36.JL-58-24	4	4593.53	1.9	0.11	87.9	44.24	1.8	48.JL-64-29	10	1873.56	31.56	0.83			32.57	10.38	1.65
37.JL-58-25	12	7775.44	2.5	0.12	118.12	34.57	2.03	49.JL-64-30	6	3438.31	21.91	0.65	19.73	0.55	16.19	6.64	1.52
40.JL-58-26	7	4305.03	2.53	0.15	122.92	47.03	2.01	51.JL-64-31	19	3302.33	45.24	1.07			24.51	5.75	2.01
41.JL-58-27	6	9384.01	2.56	0.17	48.05	19.87	1.82	52.JL-64-32	7	2745.70	33.33	0.86			14.75	5.62	1.41
42.JL-58-28	2	2201.4	2.98	0.13	58.6	41.52	1.82	55.JL-64-33	3	2358.14	16.48	0.37			14.89	8.62	1.51
43.JL-58-29	6	3641.32	2.81	0.1	112.25	46	2.14	56.JL-64-34	6	1418.10	30.71	0.56			26.55	10.87	1.56
44.JL-58-30	5	7939.62	2.46	0.09	49.24	22.1	1.92	57.JL-64-35	5	1771.63	22.21	0.54			24.49	10.99	1.54
47.JL-58-31	7	6755.86	2.48	0.09	80.17	30.44	2.09	58.JL-64-36	8	1614.62	26.00	0.68			36.69	13.04	1.44
48.JL-58-32	5	5818.44	2.47	0.12	66.83	30.06	2.28	59.JL-64-37	8	1659.05	92.64	2.29			10.04	3.57	1.48
49.JL-58-34	7	5589.02	2.22	0.08	108.03	41.02	2.3										
50.JL-58-35	5	5154.08	2.32	0.12	80.24	36.12	2.02										
51.JL-58-36	4	6716.16	2.75	0.15	41.68	20.97	1.84										

SAMPLE: JL06-70													
Table S2:													
Grain #	Ns	Area (μm ²)	238U (μg/g)	238U 1se (μg/g)	238U-2 (μg/g)	238U-2 1se (μg/g)	238U-3 (μg/g)	238U-3 1se (μg/g)	238U-4 (μg/g)	238U-4 1se (μg/g)	Age (Ma)	Age 1se (Ma)	Dpar (μm)
5.JL-70-01	8	7959.33	4.67	0.12	4.47	0.12					42.34	15.48	1.84
8.JL-70-02	6	10963.56	6.55	0.17	4.67	0.10	3.91	0.09			21.41	8.96	2.27
13.JL-70-03	7	11713.12	4.88	0.14	4.38	0.11	4.18	0.11			25.76	10.02	2.15
16.JL-70-04	7	12107.20	4.95	0.17	4.12	0.14	3.83	0.13	4.03	0.13	26.45	10.26	2.07
22.JL-70-05	9	10266.41	3.81	0.14	3.44	0.11	3.43	0.12			47.43	16.37	2.50
27.JL-70-06	12	10434.23	4.48	0.16	4.08	0.13					51.74	15.76	2.06
29.JL-70-07	10	12517.50	5.42	0.19	5.02	0.17					29.51	9.79	2.20
35.JL-70-08	5	4181.16	4.75	0.15	4.22	0.14					51.37	23.29	2.10
37.JL-70-09	9	10914.49	4.35	0.13	4.83	0.16	3.79	0.12			36.91	12.75	2.06
42.JL-70-10	13	9107.63	3.68	0.12	4.40	0.14					68.13	19.98	2.10
46.JL-70-11	8	4664.56	4.38	0.15	4.05	0.16					78.16	28.31	2.36
50.JL-70-12	12	10820.90	4.07	0.14	4.57	0.14	4.14	0.16			50.14	15.17	2.23
53.JL-70-13	9	12083.28	3.70	0.13	4.39	0.17	4.04	0.12			35.56	12.31	2.22
59.JL-70-14	8	3930.14	3.73	0.13							104.53	38.20	2.07
61.JL-70-15	7	12312.68	4.04	0.12	3.90	0.12	3.77	0.15			28.08	10.93	2.37
66.JL-70-16	6	8039.58	3.66	0.15	3.89	0.14	3.53	0.11	3.73	0.13	38.83	16.11	1.90
72.JL-70-17	7	4708.93	4.19	0.13	4.83	0.13					63.49	24.52	2.26
76.JL-70-18	8	10760.13	4.83	0.16	4.99	0.16	4.96	0.17			29.08	10.61	2.13
82.JL-70-19	5	9195.77	4.27	0.13	4.12	0.13	3.99	0.14			25.40	11.57	2.39
87.JL-70-20	7	4457.13	4.14	0.15	3.89	0.13					75.13	28.98	2.02
89.JL-70-21	8	9552.53	3.98	0.15	3.47	0.11					43.37	15.89	2.04
91.JL-70-22	6	5831.70	3.70	0.14							53.47	22.46	2.07
94.JL-70-23	4	3464.26	4.41	0.16							50.36	25.58	1.70
95.JL-70-24	6	7649.29	4.09	0.15	4.93	0.16					33.64	14.08	2.11
97.JL-70-25	6	5290.10	5.21	0.22							41.90	17.59	2.21
98.JL-70-26	5	4617.27	4.02	0.14							51.81	23.69	2.21
101.JL-70-27	10	8902.05	3.98	0.13	4.24	0.16					52.59	17.36	1.98
103.JL-70-28	5	2691.08	4.33	0.15							82.33	37.46	2.06
104.JL-70-29	5	4852.78	4.14	0.18							47.88	21.90	2.11
105.JL-70-30	14	11446.93	4.01	0.12	4.86	0.16					53.28	15.18	2.17
109.JL-70-31	6	6422.43	4.21	0.15							42.71	17.95	2.34
110.JL-70-32	9	6561.98	4.13	0.12							63.81	22.22	2.36
111.JL-70-33	6	13373.63	3.70	0.13	6.26	0.22					17.98	7.56	2.16
113.JL-70-34	5	3537.11	4.15	0.15							65.44	29.86	1.99
116.JL-70-35	3	4798.99	3.90	0.13							30.88	18.07	2.01
117.JL-70-36	6	3174.56	3.70	0.11							97.89	40.88	1.97
118.JL-70-37	7	11919.00	3.25	0.13	3.61	0.14					33.02	12.91	2.35
120.JL-70-38	10	7071.30	4.20	0.12	4.12	0.14					65.31	21.48	2.20

SAMPLE: JL06-73							
Table S2:							
Grain #	Ns	Area (μm²)	238U (μg/g)	238U 1se (μg/g)	Age (Ma)	Age 1se (Ma)	Dpar (μm)
5.JL-73-01	20	12124.6	5.21	0.27	60.85	13.97	2.52
6.JL-73-03	8	2608.48	7.82	0.24	75.29	26.72	2.51
7.JL-73-04	7	2326.57	8.67	0.33	66.66	25.32	4.75
8.JL-73-05	5	3151.77	5.72	0.22	53.33	23.94	2.64
9.JL-73-06	9	4206.27	6.13	0.22	67.05	22.48	2.9
12.JL-73-07	7	2978.41	5.01	0.19	89.95	34.17	2.69
13.JL-73-08	4	3184.53	6.69	0.34	36.15	18.17	3.84
14.JL-73-09	6	3018.19	5.26	0.17	72.57	29.72	2.57
15.JL-73-10	4	1518.22	4.06	0.18	124.11	62.30	2.48
16.JL-73-11	7	2221.65	6.01	0.2	100.45	38.11	2.92
19.JL-73-12	7	3577.75	6.26	0.13	60.07	22.74	2.97
20.JL-73-13	5	1592.05	10.98	0.5	55.00	24.72	3.07
21.JL-73-14	4	3548.54	3.73	0.13	58.09	29.12	2.88
22.JL-73-15	11	10167.01	3.96	0.14	52.54	15.95	2.93
23.JL-73-17	6	3076.45	6.36	0.16	58.94	24.11	2.85
26.JL-73-18	10	3836.73	4.95	0.19	100.88	32.14	2.74
27.JL-73-19	5	1362.35	6.61	0.25	106.33	47.72	2.78
28.JL-73-20	7	5431.07	5.98	0.31	41.49	15.83	2.36
29.JL-73-21	4	2306.48	8.08	0.24	41.31	20.69	2.19
30.JL-73-22	9	2793.93	6.05	0.25	102.00	34.26	2.73
33.JL-73-23	6	2122.99	11.45	0.32	47.49	19.43	2.37
34.JL-73-24	5	2628.66	6.13	0.24	59.64	26.77	2.62
35.JL-73-25	3	2231.14	6.21	0.2	41.68	24.10	3
36.JL-73-26	9	2700.42	5.68	0.22	112.32	37.69	2.26
37.JL-73-27	4	7883.62	7.3	0.27	13.41	6.72	2.47
40.JL-73-28	17	4142.59	18.75	0.82	42.12	10.38	2.49
41.JL-73-29	8	2698.6	5.55	0.17	102.33	36.31	3.01
42.JL-73-30	7	3214.66	5.22	0.13	80.05	30.32	2.4
43.JL-73-31	6	3859.52	5.14	0.17	58.14	23.81	2.48
44.JL-73-32	7	2938.2	12.03	0.25	38.13	14.43	2.62
47.JL-73-33	6	1670.31	5.13	0.22	133.81	54.93	3.21
48.JL-73-34	6	4672.57	2.17	0.1	113.26	46.53	2.15
49.JL-73-35	5	4540.77	6.77	0.25	31.33	14.06	3.13

SAMPLE: JL06-90									
Table S2:									
Grain #	Ns	Area (μm²)	238U (μg/g)	238U 1se (μg/g)	238U-2 (μg/g)	238U-2 1se (μg/g)	Age (Ma)	Age 1se (Ma)	Dpar (μm)
5.JL-90-01	11	10798.28	4.99	0.14			39.30	12.46	1.79
6.JL-90-02	14	11771.44	5.55	0.16			41.25	11.75	2.15
7.JL-90-03	10	14424.41	8.30	0.23	9.87	0.25	14.77	4.88	2.42
9.JL-90-04	10	13198.47	5.13	0.16			28.46	9.43	2.24
12.JL-90-05	10	17847.22	5.11	0.15	4.80	0.16	21.81	7.21	1.83
14.JL-90-06	9	12688.67	4.50	0.12			30.37	10.56	2.07
15.JL-90-07	10	13641.84	6.36	0.17	5.66	0.18	23.55	7.77	1.99
19.JL-90-08	5	7618.36	5.27	0.15	7.23	0.21	20.50	9.33	1.94
21.JL-90-09	7	9321.43	5.19	0.13			27.88	10.88	1.82
22.JL-90-10	10	12740.10	5.12	0.15			29.54	9.79	1.68
23.JL-90-11	16	16671.91	5.31	0.16			34.81	9.38	2.09
26.JL-90-12	16	14385.11	6.38	0.16	9.03	0.27	28.23	7.55	2.11
28.JL-90-13	6	6038.07	4.96	0.17			38.57	16.15	2.45
29.JL-90-14	10	6823.93	5.81	0.17			48.52	16.01	2.26
30.JL-90-15	11	10770.55	5.61	0.15	5.82	0.16	34.42	10.85	2.23
34.JL-90-16	9	9167.28	6.04	0.19			31.31	10.87	2.31
35.JL-90-17	7	7510.34	5.09	0.17			35.26	13.75	1.92
36.JL-90-18	7	14633.52	5.58	0.19			16.53	6.46	1.92
37.JL-90-19	9	10355.89	5.66	0.20			29.58	10.28	1.91
38.JL-90-20	13	13556.70	6.19	0.21			29.85	8.80	1.99
41.JL-90-21	8	3557.56	4.87	0.15			88.55	32.19	2.04
42.JL-90-22	6	3793.35	4.09	0.13	4.19	0.12	73.36	30.34	1.98
44.JL-90-23	6	5620.88	4.65	0.14			44.18	18.49	2.01
48.JL-90-25	9	9594.24	5.28	0.19	5.45	0.19	33.68	11.63	1.55
50.JL-90-26	4	5669.84	5.82	0.17			23.36	11.88	1.90
51.JL-90-27	7	7705.90	7.35	0.23			23.82	9.29	1.77
52.JL-90-28	5	3842.78	5.08	0.14			49.27	22.44	1.59
55.JL-90-29	7	8935.49	5.11	0.16	5.07	0.17	29.65	11.51	1.77
57.JL-90-30	7	3775.62	5.24	0.18			67.96	26.34	1.89
58.JL-90-31	5	5156.15	8.51	0.23			21.97	10.02	1.86
59.JL-90-32	5	5841.13	5.96	0.20			27.67	12.64	2.09
62.JL-90-33	16	15707.11	4.76	0.15	4.97	0.15	40.31	10.79	1.92
64.JL-90-34	14	12345.58	5.03	0.17	4.70	0.13	44.88	12.70	2.45
66.JL-90-35	8	20101.55	4.37	0.14			17.56	6.46	2.07
69.JL-90-36	10	12860.12	4.67	0.14			32.07	10.63	1.87
70.JL-90-37	7	7444.17	6.39	0.17	6.33	0.19	28.49	11.04	2.05
72.JL-90-38	6	6938.37	4.55	0.18	5.02	0.16	34.85	14.52	2.10

SAMPLE: DC06-61							
Table S2:							
Grain #	Ns	Area (μm^2)	238U ($\mu\text{g/g}$)	238U 1se ($\mu\text{g/g}$)	Age (Ma)	Age 1se (Ma)	Dpar (μm)
8.DC-61-04	6	4098.47	8.94	0.17	31.54	12.89	2.35
9.DC-61-05	5	2485.11	7.96	0.21	48.62	21.78	2.02
12.DC-61-07	10	2808	6.83	0.11	99.91	31.63	2
13.DC-61-08	6	1684.5	12.3	0.23	55.68	22.75	2.15
14.DC-61-09	27	2627.62	113.44	1.61	17.47	3.37	2.3
15.DC-61-10	14	1436.12	35.91	0.87	52.21	14.01	2.04
19.DC-61-12	7	2529.74	21.26	0.51	25.08	9.50	2.14
20.DC-61-13	12	2701.42	7.31	0.19	116.29	33.70	2.16
21.DC-61-14	4	3163.92	7.58	0.16	32.13	16.08	2.19
23.DC-61-16	11	2639.69	17.56	0.33	45.66	13.79	2.11
27.DC-61-18	11	4651.93	6.87	0.16	66.12	20.00	2.11
28.DC-61-19	11	7821.39	10.13	0.16	26.75	8.08	2.46
30.DC-61-21	38	3493.29	82.95	0.89	25.27	4.11	2.25
33.DC-61-22	4	3076.55	7.45	0.15	33.61	16.82	2.06
34.DC-61-23	12	2750.4	9.42	0.21	88.82	25.72	2.35
35.DC-61-24	3	3486.42	5.39	0.16	30.75	17.78	2.1
36.DC-61-25	8	2496.6	12.13	0.19	50.81	17.98	2.23
41.DC-61-29	23	1137.51	183.09	2.13	21.29	4.45	2.32
42.DC-61-30	9	3901.69	10.03	0.22	44.26	14.78	1.64
43.DC-61-31	13	4184.45	8.11	0.18	73.55	20.46	2.12
44.DC-61-32	6	1510.78	11.05	0.22	69.03	28.22	2.16

SAMPLE: DC06-62							
Table S2:							
Grain #	Ns	Area (µm²)	238U (µg/g)	238U 1se (µg/g)	Age (Ma)	Age 1se (Ma)	Dpar (µm)
5.DC-62-03	19	1843.88	18.2	0.33	108.41	24.95	2.33
13.DC-62-10	9	4471.51	7.18	0.14	53.90	18.00	1.81
14.DC-62-11	21	4505.08	23.48	0.6	38.22	8.40	1.82
15.DC-62-12	7	7072.31	3.94	0.12	48.33	18.33	2.36
16.DC-62-13	13	5824.43	6.32	0.14	67.84	18.87	2.13
19.DC-62-14	8	4110.52	11.45	0.19	32.74	11.59	1.82
20.DC-62-15	11	3455.68	7.59	0.21	80.48	24.37	1.77
21.DC-62-16	31	2740.06	10.38	0.21	207.10	37.43	2.05
22.DC-62-17	12	3288.72	17.26	0.31	40.69	11.77	1.99
23.DC-62-18	6	3773.85	6.53	0.14	46.84	19.15	1.95
26.DC-62-19	7	5741.04	7.31	0.17	32.13	12.17	2.16
27.DC-62-20	7	3271.94	11.06	0.19	37.24	14.09	1.86
29.DC-62-23	11	5151.15	11.23	0.23	36.61	11.07	2.14
33.DC-62-25	18	7651.99	6.07	0.1	74.40	17.58	1.95
34.DC-62-26	6	2628.29	15.33	0.24	28.69	11.72	2.01
35.DC-62-27	13	3656.36	9.77	0.18	69.89	19.43	2.29
36.DC-62-28	13	3555.4	8.83	0.2	79.47	22.11	2.3
37.DC-62-29	7	2763.74	15.25	0.27	31.99	12.11	2.01
40.DC-62-30	8	3784.45	10.14	0.2	40.13	14.21	2.41
41.DC-62-31	8	3767.24	8.9	0.23	45.91	16.28	2.19
42.DC-62-32	4	2143.89	10.96	0.3	32.79	16.42	2.06
43.DC-62-33	12	4896.74	7.62	0.2	61.80	17.92	2.4
44.DC-62-34	8	3028.15	9.54	0.23	53.25	18.87	2.48
47.DC-62-35	7	5118.97	7.06	0.19	37.29	14.13	1.91
49.DC-62-37	10	6003.54	6.08	0.16	52.69	16.72	2.19
50.DC-62-38	26	4760.41	58.86	0.76	17.89	3.52	2.68
51.DC-62-39	18	6462.99	12.72	0.27	42.14	9.97	2.45
52.DC-62-40	9	5328.6	7	0.17	46.42	15.52	2.21
*DC-62-16 and -38 are deleted in thermal modelling as the two outliers							

SAMPLE: VI2001							
Table S2:							
Grain #	Ns	Area (µm²)	238U (µg/g)	238U 1se (µg/g)	Age (Ma)	Age 1se (Ma)	Dpar (µm)
5.VI-01-01	3	5311.55	2.98	0.1	36.49	21.11	3.28
6.VI-01-02	4	5122.17	2.39	0.08	62.79	31.46	2.45
7.VI-01-03	3	6232.19	2.58	0.07	35.93	20.77	2.93
8.VI-01-04	3	5741.32	2.3	0.08	43.72	25.29	2.85
9.VI-01-05	5	5643.31	2.37	0.08	71.79	32.2	2.98
12.VI-01-06	5	3633.87	2.75	0.1	95.9	43.03	1.95
13.VI-01-07	9	7108.27	2.64	0.09	91.95	30.81	3
14.VI-01-08	3	6157.63	2.22	0.08	42.24	24.43	2.88
15.VI-01-09	3	5015.5	1.87	0.08	61.47	35.59	2.43
16.VI-01-10	3	3642.66	2.23	0.06	70.92	40.99	2.39
19.VI-01-11	4	2304.2	2.38	0.07	139.33	69.78	2.14
20.VI-01-12	7	7767.95	2.37	0.08	73.01	27.7	3
21.VI-01-13	4	5720.17	2.91	0.07	46.24	23.14	2.63
22.VI-01-14	7	4675.56	2.96	0.08	96.93	36.73	2.2
23.VI-01-15	3	4888.7	2.3	0.07	51.32	29.67	2.59
26.VI-01-16	1	10916.51	2.18	0.07	8.11	8.11	2.73
29.VI-01-19	2	9605.12	2.03	0.07	19.78	14	2.91
30.VI-01-20	5	5588.74	2.79	0.07	61.62	27.6	1.93
33.VI-01-21	2	3973.66	2.73	0.09	35.5	25.13	2.6
34.VI-01-22	5	5479.85	3	0.12	58.46	26.25	2.84
35.VI-01-23	3	3096.01	2.63	0.08	70.75	40.91	2.13
36.VI-01-24	3	6031.3	2.55	0.07	37.56	21.71	3.03
37.VI-01-25	3	4949.02	2.05	0.08	56.85	32.9	2.77
40.VI-01-26	4	4146.85	2.79	0.08	66.42	33.26	2.29
41.VI-01-27	4	7118.75	2.93	0.1	36.92	18.51	2.51
42.VI-01-28	2	5676.05	2.09	0.05	32.47	22.97	2.84
43.VI-01-29	5	5531.88	2.53	0.06	68.62	30.73	2.71

SAMPLE: VI2002							
Table S2:							
Grain #	Ns	Area (µm²)	238U (µg/g)	238U 1se (µg/g)	Age (Ma)	Age 1se (Ma)	Dpar (µm)
6.VI-02-02	12	2441.79	6.85	0.13	137.07	39.65	2.35
7.VI-02-03*	10	1819.93	5.68	0.12	184.14	58.36	2.17
9.VI-02-05	10	3175.72	12.94	0.25	46.82	14.83	2.71
14.VI-02-08	7	4600	10.38	0.18	28.25	10.69	2.62
15.VI-02-09	2	2979.31	1.06	0.04	121.14	85.78	1.59
16.VI-02-10	5	2193.19	4.72	0.11	92.60	41.47	1.86
21.VI-02-14	4	2675.55	5.81	0.16	49.50	24.79	2.14
22.VI-02-15	4	2522.85	6.8	0.17	44.87	22.46	2.46
27.VI-02-18	9	3496.6	7.99	0.16	61.91	20.67	1.98
34.VI-02-23	6	4252.63	8.7	0.15	31.24	12.77	2.26
35.VI-02-24	5	2603.78	5.06	0.13	72.87	32.64	1.95
40.VI-02-27	9	3408	6.31	0.11	80.31	26.81	1.73
41.VI-02-29	10	4150.69	4.87	0.12	94.83	30.08	2.01
43.VI-02-31	7	4746.04	4.42	0.1	64.12	24.28	2.56
44.VI-02-32	4	2993.69	5.24	0.17	49.05	24.58	2.23
47.VI-02-33	5	7596.36	6.59	0.14	19.26	8.62	2.38
48.VI-02-34	5	2134.52	10.06	0.19	44.81	20.06	1.92
49.VI-02-36	7	4688.65	8.4	0.18	34.23	12.96	2.22

Table A.3: Summary of track length data for individual samples.

SAMPLE: JL06-46									
Length Name	Length Number	Apparent Length (µm)	Angle to CAxis (°)	Dpar (µm)	Corrected Z Depth (µm)	True Length (µm)	Azimuth (°)	Dip (°)	TINT/TINCLE
Length01	1	6.19	83.42	2.08	1.47	6.36	83.22	13.77	T
Length02	1	12.59	77.73	2.28	0.49	12.60	77.72	2.23	T
Length04	1	6.96	42.40	1.89	0.00	6.96	42.40	0.00	C
Length06	1	12.00	71.43	2.19	2.45	12.25	71.01	11.80	T
Length07	1	11.86	72.61	2.19	2.94	12.22	72.03	14.38	T
Length09	1	8.21	87.07	2.19	0.49	8.22	87.07	3.43	C
Length11	1	11.09	36.85	2.10	0.98	11.13	36.55	5.08	T
Length12	1	12.00	66.55	1.75	1.47	12.09	66.36	7.05	T
Length13	1	8.66	87.59	1.51	0.49	8.67	87.59	3.25	T
Length13	2	7.98	71.04	1.51	2.94	8.50	69.54	21.66	T
Length14	1	13.50	65.02	2.03	4.91	14.36	63.04	21.32	T
Length15	1	11.41	63.79	2.25	0.98	11.45	63.69	4.94	T
Length16	1	11.60	40.24	2.15	0.49	11.61	40.18	2.42	T
Length16	2	13.29	26.07	2.15	0.49	13.30	25.99	2.12	T
Length18	1	9.33	67.51	1.95	0.49	9.34	67.48	3.02	T
Length19	1	13.10	85.23	2.02	0.49	13.10	85.22	2.15	T
Length21	1	13.71	53.52	2.26	0.49	13.72	53.50	2.05	T
Length22	1	11.30	74.20	2.08	4.91	12.32	72.41	25.74	T
Length23	1	12.78	75.16	2.07	0.49	12.79	75.14	2.20	T
Length25	1	12.72	72.97	1.88	0.98	12.76	72.92	4.43	C
Length28	1	10.28	49.48	2.23	1.96	10.47	48.55	11.00	T
Length29	1	14.44	39.24	2.35	0.49	14.45	39.20	1.95	T
Length29	2	13.45	33.91	2.35	1.96	13.60	32.98	8.39	T
Length30	1	13.51	74.63	2.39	3.93	14.07	73.92	16.89	T
Length31	1	11.80	34.30	2.26	0.49	11.81	34.23	2.38	T
Length32	1	11.32	55.25	2.08	1.96	11.49	54.64	9.99	T
Length33	1	8.90	65.85	2.05	2.45	9.23	64.81	16.01	T
Length34	1	13.86	71.09	2.30	1.96	14.00	70.89	8.14	C
Length35	1	12.07	77.23	2.09	1.96	12.23	77.05	9.36	T
Length38	1	11.32	71.15	2.16	0.98	11.36	71.08	4.97	T
Length39	1	11.07	80.11	2.17	3.93	11.75	79.41	20.77	T
Length40	1	13.28	60.86	2.39	0.00	13.28	60.86	0.00	T
Length41	1	13.12	82.06	2.04	3.44	13.56	81.77	15.18	T
Length42	1	10.24	58.24	2.34	0.49	10.26	58.20	2.75	T
Length43	1	13.28	68.78	2.39	1.47	13.36	68.64	6.37	T
Length45	1	11.91	37.65	2.31	0.49	11.92	37.59	2.36	T
Length46	1	13.59	56.79	2.26	5.89	14.81	52.57	25.68	T
Length47	1	13.26	55.39	2.25	6.87	14.94	48.39	31.21	T
Length49	1	10.48	62.35	2.08	0.98	10.52	62.22	5.38	T
Length51	1	11.14	56.21	2.08	0.98	11.18	56.06	5.06	T
Length52	1	11.96	51.72	2.15	0.98	12.00	51.57	4.71	C
Length53	1	7.24	80.22	2.09	0.00	7.24	80.22	0.00	T
Length55	1	12.15	63.53	1.97	0.98	12.19	63.44	4.63	T
Length56	1	13.79	65.05	2.11	2.45	14.01	64.61	10.25	T
Length57	1	13.41	69.17	2.10	0.49	13.42	69.16	2.10	C
Length58	1	13.96	65.09	2.43	3.44	14.38	64.24	14.24	T
Length59	1	11.55	65.98	2.22	0.49	11.56	65.96	2.43	T
Length59	1	9.89	63.25	2.22	3.93	10.64	60.63	23.40	C
Length60	1	12.59	86.58	2.22	3.44	13.05	86.44	15.84	T
Length61	1	11.26	41.26	2.58	0.49	11.27	41.20	2.50	C
Length62	1	12.53	85.37	2.27	1.47	12.61	85.34	6.75	T
Length63	1	14.71	27.51	2.18	0.49	14.72	27.45	1.91	T
Length64	1	12.74	39.07	2.28	2.45	12.97	37.71	11.11	T
Length65	1	12.16	73.71	2.09	1.47	12.25	73.58	6.95	T
Length66	1	10.52	60.73	1.94	0.49	10.54	60.69	2.67	T
Length67	1	13.37	50.56	2.12	1.47	13.46	50.27	6.32	T
Length68	1	14.72	51.17	2.28	0.98	14.76	51.07	3.82	T
Length69	1	9.90	68.93	2.19	2.94	10.33	67.88	17.31	T
Length70	1	13.81	44.82	2.32	2.45	14.02	43.88	10.24	T
Length71	1	10.35	56.47	2.49	0.98	10.40	56.30	5.44	T
Length72	1	13.44	84.22	2.28	0.49	13.44	84.21	2.09	T
Length73	1	12.81	78.77	2.33	4.91	13.72	77.83	22.53	T
Length74	1	10.54	67.44	2.46	1.47	10.64	67.20	8.03	T
Length75	1	12.28	81.06	2.22	0.98	12.32	81.03	4.59	T
Length76	1	12.03	56.44	2.04	0.49	12.04	56.40	2.34	T
Length77	1	8.60	69.92	2.22	0.98	8.66	69.78	6.55	T
Length78	1	12.82	47.54	2.31	2.45	13.06	46.54	11.03	T
Length80	1	13.47	31.44	2.34	1.47	13.55	30.87	6.27	T
Length82	1	13.79	62.33	2.18	0.49	13.80	62.31	2.04	T
Length83	1	11.11	82.42	2.01	0.49	11.12	82.41	2.53	T
Length84	1	12.39	72.39	2.09	1.47	12.47	72.26	6.83	T
Length85	1	11.49	85.92	2.18	0.00	11.49	85.92	0.00	T
Length86	1	10.60	53.26	2.01	0.49	10.62	53.22	2.65	T
Length87	1	11.00	73.48	2.11	2.94	11.39	72.84	15.53	T
Length89	1	11.35	72.61	1.84	0.49	11.36	72.59	2.48	T
Length90	1	13.32	63.49	2.22	2.45	13.54	62.99	10.62	T
Length91	1	12.86	83.15	2.13	2.94	13.19	82.96	13.24	T
Length91	2	7.68	75.41	2.13	0.49	7.69	75.38	3.66	T
Length92	1	8.91	62.51	1.94	1.96	9.13	61.76	12.73	T
Length94	1	13.49	64.29	2.14	0.00	13.49	64.29	0.00	T
Length95	1	9.13	75.09	2.20	0.98	9.19	75.00	6.17	T
Length96	1	9.40	51.20	2.29	1.96	9.60	50.15	12.06	C
Length96	2	11.27	49.49	2.29	1.47	11.36	49.06	7.51	C
Length97	1	11.63	54.85	2.19	2.45	11.89	53.92	12.18	T
Length100	1	11.07	48.78	2.09	2.45	11.34	47.49	12.81	T
Length101	1	13.20	54.28	2.24	1.96	13.34	53.82	8.55	C
Length102	1	8.83	50.65	2.12	0.00	8.83	50.65	0.00	T
Length103	1	13.93	72.07	2.25	0.00	13.93	72.07	0.00	T
Length104	1	12.76	68.81	2.19	0.98	12.80	68.75	4.41	T
Length105	1	13.44	78.60	2.40	0.98	13.47	78.57	4.19	T
Length106	1	12.63	46.61	2.18	1.47	12.71	46.24	6.70	T
Length107	1	11.84	52.27	1.94	1.47	11.93	51.92	7.14	T
Length108	1	9.65	57.97	2.19	3.44	10.24	55.42	20.86	T
Length109	1	13.13	61.33	2.17	1.47	13.22	61.13	6.44	T
Length110	1	11.74	53.18	1.61	3.93	12.38	50.52	19.53	T
Note:									
TINT - track-in-track, a confined track which intersects asurface track.									
TINCLE - track-in-cleavage, a confined track which intersectsa crack or cleavage.									

SAMPLE: JL06-51									
Length Name	Length Number	Apparent Length (µm)	Angle to CAxis (°)	Dpar (µm)	Corrected Z Depth (µm)	True Length (µm)	Azimuth (°)	Dip (°)	INT/TINCL
Length01	1	10.97	69.35	1.76	0.49	10.99	69.33	2.56	T
Length02	1	10.56	2.79	1.82	0.49	10.57	0.83	2.66	C
Length03	1	7.81	38.59	1.99	1.47	7.94	37.25	10.87	T
Length04	1	8.67	52.68	2.04	0.98	8.73	52.39	6.50	C
Length06	1	12.40	76.64	1.94	0.49	12.41	76.63	2.27	T
Length07	1	7.71	55.99	2.14	1.47	7.85	55.26	11.01	T
Length10	1	8.92	46.30	2.02	3.44	9.55	41.52	22.67	T
Length10	2	8.57	67.17	2.02	0.98	8.63	67.01	6.58	T
Length10	3	7.83	75.20	2.02	0.49	7.84	75.17	3.59	T
Length11	1	10.99	67.61	1.94	1.47	11.09	67.40	7.70	C
Length14	1	11.06	53.43	1.89	0.49	11.07	53.39	2.54	C
Length15	1	11.80	68.83	2.05	0.00	11.80	68.83	0.00	T
Length16	1	9.69	25.97	2.08	0.00	9.69	25.97	0.00	T
Length17	1	13.02	38.21	2.12	0.49	13.03	38.15	2.16	C
Length18	1	13.04	51.50	1.94	0.49	13.05	51.47	2.16	C
Length19	1	10.73	80.01	2.02	1.47	10.83	79.91	7.89	T
Length19	2	11.54	47.91	2.02	0.49	11.55	47.87	2.44	T
Length19	1	11.06	15.83	2.02	0.00	11.06	15.83	0.00	C
Length20	1	10.65	72.88	1.85	2.94	11.05	72.16	16.05	T
Length21	1	7.32	66.76	1.98	1.47	7.46	66.25	11.61	T
Length23	1	12.18	31.09	2.23	2.94	12.53	28.05	13.99	T
Length24	1	12.15	65.95	1.86	0.00	12.15	65.95	0.00	T
Length25	1	10.03	60.85	1.97	0.49	10.04	60.81	2.80	T
Length26	1	11.93	78.58	2.01	0.98	11.97	78.54	4.72	T
Length27	1	8.54	51.01	2.39	0.49	8.55	50.94	3.30	T
Length27	2	12.38	21.89	2.39	2.45	12.62	18.80	11.44	T
Length28	1	12.75	81.77	1.64	0.98	12.79	81.75	4.41	T
Length29	1	10.36	61.42	2.31	0.00	10.36	61.42	0.00	T
Length31	1	12.63	38.61	2.08	0.00	12.63	38.61	0.00	T
Length32	1	11.68	64.08	2.20	4.91	12.67	61.20	24.84	C
Length33	1	8.14	62.43	2.12	0.49	8.16	62.37	3.46	T
Length34	1	8.39	57.63	1.76	1.47	8.51	57.06	10.11	T
Length35	1	11.45	67.95	1.97	0.49	11.46	67.93	2.46	T
Length35	1	10.87	30.16	1.97	0.00	10.87	30.16	0.00	C
Length36	1	10.46	78.81	1.90	0.49	10.48	78.80	2.69	T
Length37	1	10.35	51.84	2.03	0.49	10.36	51.79	2.72	T
Length38	1	9.71	58.71	2.01	0.00	9.71	58.71	0.00	T
Length39	1	10.87	78.09	1.93	2.94	11.26	77.62	15.71	T
Length41	1	12.35	62.66	1.86	0.49	12.36	62.64	2.28	T
Length42	1	10.87	46.49	2.04	0.49	10.88	46.44	2.59	T
Length42	2	9.31	9.37	2.04	0.98	9.36	7.17	6.05	T
Length46	1	11.37	53.43	1.87	1.47	11.46	53.07	7.44	T
Length47	1	12.12	48.94	2.01	2.45	12.36	47.88	11.68	T
Length47	2	10.21	83.00	2.01	0.49	10.23	82.99	2.75	T
Length48	1	12.28	50.02	1.98	2.45	12.52	49.03	11.53	T
Length49	1	12.15	68.08	1.94	0.49	12.16	68.06	2.32	T
Length50	1	8.52	64.12	2.18	3.44	9.18	61.51	23.80	T
Length51	1	8.68	47.90	2.04	1.47	8.81	47.14	9.76	T
Length53	1	9.24	79.83	2.16	0.49	9.25	79.81	3.04	T
Length54	1	10.94	75.81	1.89	0.49	10.95	75.79	2.57	T
Length55	1	11.30	80.33	2.12	0.98	11.34	80.30	4.98	T
Length56	1	12.81	81.80	2.02	0.98	12.85	81.77	4.39	T
Length57	1	13.43	40.62	2.10	1.96	13.57	39.89	8.41	C
Length59	1	6.72	62.07	1.92	0.00	6.72	62.07	0.00	T
Length59	2	10.96	34.27	1.92	0.98	11.00	33.93	5.14	T
Length60	1	9.05	50.23	1.74	0.49	9.06	50.16	3.11	T
Length61	1	8.86	50.98	1.93	0.00	8.86	50.98	0.00	T
Length62	1	11.25	61.73	2.11	4.91	12.27	58.24	25.88	T
Length62	2	9.10	25.65	2.11	1.96	9.30	22.60	12.47	T
Length63	1	8.85	41.32	1.78	1.96	9.07	39.63	12.81	T
Length64	1	12.27	36.49	1.79	0.49	12.28	36.43	2.29	T
Length65	1	7.86	59.74	1.92	0.49	7.87	59.68	3.58	T
Length66	1	11.13	36.16	1.85	0.00	11.13	36.16	0.00	T
Length67	1	8.81	52.11	1.73	0.49	8.82	52.04	3.19	T
Length68	1	11.65	62.43	1.84	1.47	11.74	62.19	7.26	C
Length70	1	9.46	38.56	2.31	0.49	9.47	38.47	2.97	T
Length71	1	9.33	67.98	2.26	0.98	9.38	67.85	6.04	T
Length72	1	10.70	69.56	1.77	0.49	10.71	69.53	2.63	T
Length74	1	12.62	21.90	1.93	0.98	12.66	21.46	4.46	T
Length76	1	11.78	84.32	2.09	0.00	11.78	84.32	0.00	C
Length78	1	7.53	31.70	1.97	1.47	7.67	29.83	11.28	T
Length79	1	11.86	67.60	1.91	0.00	11.86	67.60	0.00	T
Length79	2	10.29	31.07	1.91	0.98	10.34	30.63	5.47	T
Length80	1	12.75	73.74	1.98	7.85	14.98	69.18	38.00	C
Length81	1	11.38	76.03	1.94	0.00	11.38	76.03	0.00	T
Length82	1	12.95	25.09	1.99	1.47	13.03	24.28	6.53	T
Length83	1	7.85	53.58	2.01	1.47	7.99	52.81	10.81	C
Length83	2	8.32	66.14	2.01	0.98	8.37	65.96	6.78	C
Length84	1	12.73	76.51	2.32	4.91	13.64	75.36	22.69	T
Length84	2	8.38	77.14	2.32	0.49	8.40	77.12	3.36	T
Length85	1	10.18	42.19	2.14	0.00	10.18	42.19	0.00	C
Length87	1	8.88	64.41	2.28	0.49	8.90	64.37	3.17	T
Length87	2	9.78	82.54	2.28	0.00	9.78	82.54	0.00	T
Length87	3	8.38	80.47	2.28	1.47	8.51	80.31	10.12	T
Length88	1	11.59	88.50	1.88	1.47	11.69	88.49	7.30	T
Length89	1	9.69	75.44	1.92	2.45	9.99	74.94	14.68	T
Length91	1	12.97	59.60	1.94	0.00	12.97	59.60	0.00	T
Length92	1	10.76	20.40	2.14	0.49	10.77	20.24	2.61	T
Length92	2	10.25	70.11	2.14	0.49	10.27	70.09	2.74	T
Length93	1	10.93	74.91	1.92	0.00	10.93	74.91	0.00	T
Length95	1	12.61	65.58	1.96	0.49	12.62	65.56	2.23	T
Length96	1	10.27	29.66	2.09	0.00	10.27	29.66	0.00	T
Length97	1	11.02	87.94	1.77	0.49	11.03	87.93	2.55	C
Length98	1	11.97	31.82	1.69	0.00	11.97	31.82	0.00	C
Length100	1	11.76	78.23	1.79	0.49	11.77	78.22	2.39	T

SAMPLE: JL06-56									
Length Name	Length Number	Apparent Length (µm)	Angle to CAxis (°)	Dpar (µm)	Corrected Z Depth (µm)	True Length (µm)	Azimuth (°)	Dip (°)	TINT/TI NCLE
Length01	1	13.42	59.27	1.48	0.00	13.42	59.27	0.00	T
Length02	1	13.44	58.15	1.48	0.98	13.47	58.05	4.19	T
Length03	1	13.90	57.48	1.79	0.49	13.91	57.46	2.02	T
Length04	1	9.51	58.50	1.95	0.49	9.53	58.46	2.96	C
Length05	1	9.26	48.15	1.78	1.96	9.47	46.94	12.24	C
Length06	1	11.59	70.54	1.75	2.45	11.84	70.07	12.23	T
Length07	1	12.35	74.93	1.87	2.45	12.60	74.61	11.46	C
Length08	1	11.45	45.84	1.79	3.44	11.95	43.09	17.46	C
Length09	1	11.74	43.77	1.56	2.45	11.99	42.40	12.07	C
Length10	1	11.89	49.91	1.64	0.00	11.89	49.91	0.00	C
Length11	1	12.32	28.86	1.66	5.89	13.66	4.40	28.55	T
Length12	1	12.11	72.43	1.52	2.94	12.47	71.87	14.07	T
Length13	1	11.49	77.38	1.40	1.47	11.58	77.27	7.36	T
Length13	2	9.49	71.05	1.40	0.49	9.50	71.02	2.97	T
Length14	1	11.17	84.50	1.67	0.98	11.21	84.48	5.04	T
Length15	1	10.61	36.59	1.66	1.47	10.71	35.83	7.98	T
Length16	1	10.09	5.81	1.48	0.98	10.14	1.61	5.58	C
Length18	1	12.98	72.04	1.71	1.47	13.06	71.91	6.51	C
Length19	1	9.03	30.55	1.71	0.00	9.03	30.55	0.00	C
Length20	1	8.74	64.20	1.66	1.47	8.86	63.80	9.70	C
Length21	1	10.92	59.68	1.66	1.96	11.09	59.12	10.36	T
Length22	1	12.10	61.21	1.60	1.47	12.19	60.98	6.99	C
Length23	1	9.76	75.93	1.36	0.98	9.81	75.85	5.77	T
Length24	1	12.14	29.17	1.48	2.45	12.39	26.93	11.66	C
Length26	1	10.50	54.23	1.76	1.47	10.60	53.82	8.06	C
Length27	1	9.13	53.10	1.75	0.98	9.18	52.85	6.17	T
Length28	1	13.35	57.86	1.56	3.93	13.92	56.18	17.10	T
Length29	1	11.08	49.00	1.50	1.96	11.26	48.20	10.20	T
Length30	1	12.50	59.27	1.63	0.49	12.51	59.25	2.25	T
Length31	1	11.80	49.62	1.72	2.45	12.06	48.52	12.00	T
Length32	1	10.70	42.99	1.60	1.47	10.80	42.40	7.91	T
Length33	1	11.88	60.54	1.65	0.98	11.92	60.43	4.74	T
Length33	2	10.48	61.24	1.65	0.00	10.48	61.24	0.00	T
Length34	1	10.79	81.93	1.83	0.49	10.80	81.92	2.61	C
Length35	1	10.63	50.57	1.76	0.49	10.64	50.52	2.65	T
Length36	1	12.10	55.22	1.55	1.47	12.19	54.92	6.99	T
Length37	1	12.46	77.27	1.52	0.00	12.46	77.27	0.00	C
Length38	1	10.57	73.68	1.61	2.45	10.85	73.21	13.43	T
Length39	1	12.15	60.90	1.56	0.49	12.16	60.87	2.32	T
Length40	1	11.14	19.15	1.75	0.00	11.14	19.15	0.00	T
Length43	1	10.72	53.02	1.60	0.00	10.72	53.02	0.00	T
Length44	1	9.24	17.86	1.69	0.49	9.25	17.60	3.05	T
Length45	1	11.26	32.24	1.56	0.98	11.30	31.89	5.00	T
Length46	1	11.54	70.43	1.60	4.42	12.36	68.74	22.51	C
Length47	1	10.99	43.13	1.76	0.49	11.01	43.07	2.56	C
Length48	1	10.53	64.06	1.71	1.96	10.71	63.56	10.74	T
Length49	1	11.89	40.67	1.66	2.45	12.14	39.18	11.91	T
Length50	1	11.95	55.51	1.73	0.00	11.95	55.51	0.00	T
Length51	1	12.71	69.73	1.66	1.47	12.79	69.59	6.65	C
Length52	1	10.67	43.59	1.45	2.45	10.95	41.91	13.30	T
Length53	1	10.50	48.91	1.55	4.42	11.39	43.57	24.88	T
Length54	1	12.42	70.89	1.54	0.98	12.46	70.83	4.53	T
Length55	1	10.91	62.27	1.48	0.49	10.92	62.24	2.58	C
Length56	1	11.29	39.72	1.57	0.49	11.30	39.66	2.49	T
Length57	1	10.31	39.27	1.60	1.47	10.41	38.54	8.21	C
Length58	1	11.66	62.67	1.66	0.00	11.66	62.67	0.00	T
Length59	1	9.89	78.88	1.52	0.98	9.94	78.82	5.69	C
Length60	1	12.28	37.40	1.66	0.98	12.32	37.16	4.58	T
Length61	1	11.60	2.42	1.60	0.49	11.61	0.03	2.42	C
Length62	1	9.81	72.83	1.44	2.45	10.11	72.25	14.49	C
Length63	1	11.09	77.74	1.56	4.42	11.94	76.62	23.47	T
Length64	1	12.07	55.76	1.49	0.49	12.08	55.73	2.33	T
Length65	1	10.87	74.53	1.52	0.49	10.88	74.51	2.59	T
Length66	1	10.78	53.83	1.71	1.47	10.88	53.44	7.85	T
Length67	1	13.80	78.37	1.57	0.98	13.84	78.34	4.08	T
Length68	1	11.03	47.64	1.57	0.49	11.04	47.59	2.55	T
Length69	1	11.27	65.53	1.66	0.98	11.31	65.43	5.00	T
Length70	1	9.40	54.38	1.50	0.98	9.45	54.15	6.00	C
Length71	1	13.12	70.80	1.60	0.00	13.12	70.80	0.00	T
Length72	1	12.00	72.30	1.76	1.47	12.09	72.16	7.05	T
Length73	1	12.27	65.27	1.74	0.49	12.28	65.25	2.29	T
Length74	1	9.62	43.93	1.75	2.45	9.93	41.85	14.77	T
Length75	1	8.43	84.65	1.67	1.96	8.65	84.50	13.47	T
Length78	1	12.41	71.19	1.48	1.47	12.50	71.05	6.81	T
Length79	1	10.51	63.17	1.62	0.00	10.51	63.17	0.00	T
Length80	1	10.29	50.48	1.38	2.94	10.71	48.38	16.63	T
Length81	1	11.90	51.90	1.48	1.47	11.99	51.55	7.11	T
Length82	1	11.88	14.46	1.48	1.47	11.97	12.62	7.12	T
Length83	1	12.23	30.52	1.68	0.49	12.24	30.44	2.30	T
Length84	1	12.76	39.29	1.25	0.49	12.77	39.24	2.20	T
Length85	1	10.49	72.13	1.49	1.47	10.59	71.95	8.07	T
Length86	1	10.59	45.44	1.54	0.98	10.64	45.19	5.32	T
Length87	1	10.61	41.44	1.50	0.49	10.62	41.38	2.65	T
Length88	1	11.61	58.35	1.49	1.96	11.77	57.84	9.74	T
Length89	1	11.66	76.67	1.05	0.00	11.66	76.67	0.00	T
Length90	1	11.11	76.54	1.09	0.00	11.11	76.54	0.00	T
Length91	1	10.62	71.78	1.05	0.98	10.67	71.70	5.30	T
Length92	1	11.48	29.03	1.66	0.00	11.48	29.03	0.00	T
Length93	1	12.41	54.69	1.05	0.49	12.42	54.66	2.27	C
Length95	1	12.16	78.86	1.18	1.47	12.25	78.77	6.96	T

SAMPLE: JL06-58									
Length Name	Length Number	Apparent Length (µm)	Angle to CAxis (°)	Dpar (µm)	Corrected Z Depth (µm)	True Length (µm)	Azimuth (°)	Dip (°)	TINT/TI NCLE
Length01	1	7.57	82.47	2.30	0.00	7.57	82.47	0.00	T
Length02	1	9.38	76.56	2.30	0.98	9.43	76.49	6.01	C
Length03	1	13.49	44.87	2.45	0.00	13.49	44.87	0.00	T
Length04	1	9.83	68.76	2.01	1.96	10.03	68.31	11.52	C
Length05	1	10.23	84.74	2.28	2.45	10.52	84.58	13.88	T
Length06	1	11.32	60.05	2.34	1.47	11.42	59.76	7.47	T
Length07	1	11.39	84.09	2.26	1.47	11.49	84.04	7.42	C
Length08	1	11.51	87.42	2.25	2.94	11.88	87.33	14.83	T
Length09	1	12.48	60.76	2.03	4.91	13.41	57.91	23.15	T
Length10	1	10.07	68.54	2.34	1.47	10.18	68.29	8.41	T
Length11	1	12.34	72.30	2.28	2.94	12.69	71.75	13.81	T
Length12	1	12.39	81.30	2.12	1.96	12.55	81.19	9.12	T
Length13	1	10.91	67.17	1.93	2.45	11.18	66.53	13.00	T
Length14	1	10.28	83.67	2.00	0.49	10.30	83.66	2.74	C
Length15	1	12.54	30.23	2.08	0.49	12.55	30.16	2.24	T
Length16	1	11.58	63.42	2.16	0.98	11.63	63.31	4.86	C
Length17	1	11.08	74.16	2.22	1.96	11.25	73.90	10.21	T
Length18	1	12.73	85.15	2.20	3.93	13.32	84.90	17.97	T
Length19	1	11.96	83.30	2.20	0.49	11.97	83.29	2.35	C
Length20	1	10.93	61.83	2.26	0.49	10.94	61.80	2.57	C
Length21	1	13.36	59.89	2.39	3.93	13.92	58.34	17.09	T
Length22	1	12.97	39.47	2.27	2.94	13.30	37.56	13.13	T
Length23	1	8.38	15.99	2.12	0.49	8.40	15.65	3.36	T
Length24	1	12.57	49.18	2.07	2.94	12.91	47.75	13.55	C
Length26	1	10.44	65.98	2.19	0.49	10.45	65.95	2.70	T
Length27	1	11.55	58.63	2.19	2.45	11.81	57.81	12.27	T
Length28	1	12.78	57.06	2.32	1.96	12.93	56.61	8.84	T
Length30	1	13.83	47.89	2.20	0.49	13.84	47.86	2.03	T
Length31	1	10.33	74.17	2.30	3.44	10.89	73.19	19.42	T
Length32	1	8.57	75.24	2.27	0.98	8.63	75.14	6.58	T
Length33	1	11.99	85.90	2.39	0.00	11.99	85.90	0.00	C
Length34	1	13.34	76.11	2.18	5.89	14.58	74.48	26.21	T
Length35	1	12.35	73.15	2.20	2.45	12.59	72.79	11.46	T
Length36	1	11.93	58.67	2.28	0.49	11.94	58.64	2.36	C
Length37	1	11.27	66.44	2.26	5.40	12.50	62.92	28.62	T
Length38	1	12.01	75.20	2.39	0.98	12.05	75.15	4.69	T
Length39	1	13.40	16.58	2.32	0.98	13.43	16.05	4.20	T
Length40	1	12.49	67.90	2.29	0.49	12.50	67.88	2.25	T
Length41	1	12.90	68.27	2.26	0.00	12.90	68.27	0.00	T
Length42	1	12.05	86.82	2.28	0.98	12.09	86.81	4.67	T
Length43	1	9.63	42.38	2.23	0.98	9.68	42.05	5.85	T
Length44	1	10.28	85.62	2.41	0.00	10.28	85.62	0.00	T
Length45	1	12.66	52.80	2.29	0.49	12.67	52.77	2.22	C
Length46	1	10.39	47.62	2.46	0.98	10.43	47.38	5.42	C
Length47	1	10.24	85.85	2.36	1.47	10.35	85.81	8.27	T
Length48	1	11.81	60.79	2.40	2.94	12.17	59.74	14.44	T
Length48	2	11.72	49.43	2.40	1.47	11.81	49.03	7.22	T
Length49	1	12.87	55.32	2.24	0.00	12.87	55.32	0.00	C
Length50	1	9.64	50.96	2.28	1.47	9.76	50.41	8.78	C
Length51	1	12.93	46.39	2.44	0.49	12.94	46.35	2.18	T
Length52	1	12.39	14.12	2.26	0.98	12.43	13.39	4.54	T
Length53	1	11.24	89.94	1.87	1.96	11.41	89.94	10.05	C
Length57	1	10.52	61.75	2.22	2.94	10.92	60.46	16.26	T
Length58	1	10.38	70.94	2.34	0.00	10.38	70.94	0.00	C
Length59	1	13.10	80.03	2.22	3.93	13.68	79.54	17.44	T
Length60	1	13.78	80.60	2.31	1.47	13.86	80.55	6.13	T
Length61	1	9.88	80.88	2.26	0.49	9.89	80.87	2.85	T
Length62	1	9.84	64.83	2.00	1.96	10.03	64.27	11.51	T
Length63	1	11.57	57.69	2.09	0.98	11.61	57.55	4.87	C
Length64	1	12.83	44.58	2.28	0.49	12.84	44.53	2.19	T
Length65	1	13.39	35.20	2.22	0.98	13.42	34.98	4.21	T
Length66	1	11.76	79.39	2.40	2.94	12.12	79.03	14.50	T
Length68	1	10.83	80.25	2.42	3.44	11.36	79.71	18.49	C
Length69	1	13.68	68.27	2.05	0.49	13.69	68.25	2.06	T
Length69	2	10.73	3.67	2.05	0.49	10.74	2.57	2.62	T
Length70	1	11.10	89.96	2.03	1.96	11.27	89.96	10.18	T
Length71	1	10.59	75.55	2.22	2.94	10.99	74.94	16.15	C
Length72	1	12.83	15.66	2.28	0.98	12.87	15.05	4.39	T
Length73	1	10.16	65.28	2.17	0.98	10.21	65.16	5.54	T
Length74	1	12.24	71.68	2.18	4.91	13.19	69.94	23.64	T
Length75	1	11.99	76.53	2.34	3.93	12.61	75.73	19.12	T
Length76	1	11.25	68.61	2.32	0.00	11.25	68.61	0.00	T
Length76	1	12.80	88.19	2.32	1.96	12.95	88.17	8.83	C
Length77	1	13.26	79.04	2.70	2.45	13.49	78.84	10.66	C
Length78	1	13.03	89.00	2.39	0.00	13.03	89.00	0.00	T
Length79	1	12.88	69.01	2.34	4.42	13.62	67.59	20.06	T
Length80	1	9.57	88.97	2.30	2.94	10.01	88.92	17.92	C
Length81	1	13.57	72.92	2.28	1.47	13.65	72.81	6.23	T
Length82	1	13.12	50.51	2.22	0.98	13.16	50.37	4.29	T
Length83	1	8.46	88.15	2.25	0.98	8.52	88.14	6.66	T
Length83	2	9.58	72.63	2.25	1.47	9.70	72.41	8.84	T
Length84	1	11.24	82.42	2.29	0.49	11.25	82.42	2.50	T
Length85	1	10.93	87.91	2.15	1.47	11.03	87.89	7.74	C
Length86	1	13.10	43.49	2.23	0.49	13.11	43.45	2.15	T
Length86	2	11.50	89.40	2.23	0.49	11.51	89.40	2.45	T
Length87	1	12.73	46.21	2.26	0.98	12.77	46.04	4.42	T
Length88	1	11.11	73.55	2.18	0.49	11.12	73.54	2.53	T
Length89	1	12.06	86.97	2.15	0.98	12.10	86.96	4.67	T
Length90	1	12.21	38.75	2.22	0.98	12.25	38.52	4.61	T
Length91	1	13.76	83.98	2.02	0.98	13.80	83.96	4.09	T
Length92	1	12.67	49.78	2.20	2.45	12.90	48.84	11.17	T
Length93	1	10.83	59.23	2.24	0.00	10.83	59.23	0.00	T
Length93	2	11.96	45.05	2.24	0.98	12.00	44.86	4.71	T
Length95	1	11.98	45.34	2.10	1.96	12.14	44.56	9.43	T
Length96	1	11.13	70.71	2.32	1.47	11.22	70.54	7.61	C
Length97	1	12.79	69.76	2.23	0.00	12.79	69.76	0.00	T
Length98	1	10.93	86.66	2.10	1.47	11.03	86.63	7.74	T
Length99	1	12.08	65.31	2.25	1.47	12.17	65.11	7.00	C
Length100	1	11.96	79.81	2.13	0.98	12.00	79.78	4.71	T
Length101	1	13.15	68.85	2.09	0.00	13.15	68.85	0.00	T

SAMPLE: JL06-64									
Length Name	Length Number	Apparent Length (µm)	Angle to CAxis (°)	Dpar (µm)	Corrected Z Depth (µm)	True Length (µm)	Azimuth (°)	Dip (°)	TINT/TI NCLE
Length01	1	11.64	55.84	1.95	0.49	11.65	55.80	2.42	T
Length02	1	12.08	42.88	1.85	1.96	12.24	42.05	9.35	T
Length03	1	11.63	48.76	1.84	0.00	11.63	48.76	0.00	C
Length04	1	13.04	55.58	2.08	2.94	13.37	54.54	13.05	T
Length05	1	11.54	89.11	1.79	0.00	11.54	89.11	0.00	T
Length06	1	10.66	73.17	1.92	0.49	10.67	73.15	2.64	T
Length07	1	10.66	35.26	2.12	0.98	10.70	34.91	5.28	T
Length08	1	12.06	75.08	1.79	1.47	12.15	74.96	7.01	T
Length09	1	12.20	78.45	1.73	0.98	12.24	78.42	4.61	T
Length10	1	11.97	67.36	1.97	0.49	11.98	67.34	2.35	T
Length11	1	12.86	70.19	1.76	1.96	13.01	69.95	8.78	C
Length13	1	11.48	89.98	1.88	1.47	11.57	89.98	7.37	T
Length14	1	10.94	70.61	1.71	0.98	10.98	70.52	5.15	T
Length15	1	13.00	45.42	1.84	0.00	13.00	45.42	0.00	T
Length16	1	10.44	67.32	1.93	0.49	10.45	67.29	2.69	T
Length16	2	9.99	86.07	1.93	1.47	10.10	86.03	8.47	T
Length17	1	9.28	52.57	1.87	0.98	9.33	52.32	6.07	T
Length18	1	10.92	67.76	1.91	0.98	10.96	67.66	5.16	T
Length19	1	12.51	83.28	1.68	0.98	12.55	83.25	4.50	T
Length20	1	10.96	89.50	1.56	1.96	11.14	89.49	10.32	T
Length21	1	13.36	74.94	1.62	0.00	13.36	74.94	0.00	T
Length22	1	12.02	72.34	1.83	0.49	12.03	72.32	2.34	T
Length23	1	12.24	39.45	1.83	0.49	12.25	39.40	2.30	T
Length24	1	11.92	81.10	1.66	1.96	12.08	80.98	9.48	T
Length25	1	11.82	55.50	1.78	1.47	11.92	55.20	7.15	C
Length26	1	10.74	78.08	1.84	1.96	10.91	77.88	10.54	T
Length27	1	9.81	42.18	1.96	1.47	9.92	41.45	8.63	T
Length27	2	10.52	45.56	1.96	3.44	11.06	42.20	19.07	T
Length27	3	12.28	24.38	1.96	2.94	12.63	20.25	13.87	T
Length28	1	12.08	57.30	1.74	1.96	12.24	56.80	9.35	T
Length29	1	10.69	87.00	1.98	1.96	10.87	86.94	10.59	C
Length30	1	12.09	55.34	2.03	0.00	12.09	55.34	0.00	T
Length31	1	11.90	72.19	1.79	0.98	11.94	72.13	4.73	T
Length32	1	12.37	75.53	1.99	0.98	12.41	75.48	4.55	T
Length32	2	11.31	75.05	1.99	0.00	11.31	75.05	0.00	T
Length33	1	10.54	55.09	2.01	3.44	11.09	52.74	19.02	T
Length34	1	12.23	82.46	2.06	0.00	12.23	82.46	0.00	T
Length35	1	11.25	70.85	2.03	2.94	11.63	70.13	15.17	T
Length36	1	12.78	85.29	1.98	0.98	12.82	85.28	4.41	T
Length37	1	11.53	56.22	1.79	3.44	12.03	54.38	17.33	T
Length38	1	10.64	77.22	1.79	0.98	10.68	77.17	5.29	T
Length39	1	10.00	46.48	1.85	0.49	10.01	46.42	2.81	T
Length40	1	10.52	75.66	1.84	0.00	10.52	75.66	0.00	T
Length41	1	11.75	88.38	1.66	0.98	11.79	88.38	4.79	T
Length42	1	13.56	79.05	1.76	0.49	13.57	79.04	2.07	T
Length43	1	11.84	64.63	1.58	2.45	12.10	64.03	11.96	T
Length44	1	10.97	52.01	1.85	2.45	11.24	50.84	12.92	T
Length45	1	11.04	79.61	1.96	0.00	11.04	79.61	0.00	T
Length46	1	12.32	82.24	1.90	2.45	12.56	82.08	11.49	T
Length46	2	12.47	59.69	1.90	5.40	13.59	55.96	25.65	T
Length47	1	13.07	72.09	1.63	0.00	13.07	72.09	0.00	T
Length48	1	11.26	40.20	1.82	1.47	11.35	39.61	7.52	T
Length49	1	15.04	45.94	1.79	0.00	15.04	45.94	0.00	T
Length49	2	9.75	81.62	1.79	0.98	9.80	81.58	5.78	T
Length50	1	11.88	60.58	1.90	0.98	11.92	60.47	4.74	T
Length50	2	9.18	53.34	1.90	0.00	9.18	53.34	0.00	T
Length51	1	9.15	87.32	2.03	0.00	9.15	87.32	0.00	T
Length52	1	8.79	28.28	1.88	1.47	8.92	26.71	9.64	T
Length52	1	10.81	69.07	1.88	0.98	10.85	68.98	5.21	C
Length53	1	11.42	78.72	1.80	0.49	11.43	78.71	2.46	T
Length54	1	13.49	46.36	1.93	0.00	13.49	46.36	0.00	T
Length55	1	10.75	72.38	1.70	0.49	10.77	72.36	2.62	C
Length56	1	12.75	71.70	2.10	0.00	12.75	71.70	0.00	T
Length57	1	10.24	85.43	1.91	0.00	10.24	85.43	0.00	T
Length58	1	12.32	67.52	1.81	1.47	12.41	67.35	6.86	T
Length59	1	10.17	83.61	1.58	0.98	10.22	83.58	5.54	T
Length60	1	12.99	73.61	1.85	0.00	12.99	73.61	0.00	T
Length61	1	12.48	14.95	1.53	0.98	12.52	14.27	4.51	C
Length62	1	12.19	64.32	1.85	1.96	12.35	63.96	9.27	T
Length63	1	10.05	48.52	1.84	1.47	10.15	47.97	8.43	T
Length64	1	12.17	75.56	1.72	0.49	12.18	75.55	2.31	C
Length64	2	11.78	73.68	1.72	1.47	11.87	73.55	7.18	C
Length65	1	13.05	62.52	1.82	1.96	13.20	62.18	8.65	T
Length66	1	9.73	88.64	1.72	3.44	10.32	88.54	20.67	T
Length66	2	9.29	86.15	1.72	0.49	9.31	86.14	3.03	T
Length67	1	12.11	35.13	1.48	0.49	12.12	35.06	2.32	T
Length67	1	11.24	27.51	1.48	0.49	11.25	27.41	2.50	C
Length68	1	10.81	51.81	1.84	0.98	10.86	51.62	5.21	T
Length68	2	11.16	86.04	1.84	0.49	11.17	86.04	2.52	T
Length69	1	12.79	68.75	1.39	1.47	12.87	68.60	6.61	T
Length70	1	12.69	71.63	1.67	0.49	12.70	71.62	2.22	T
Length71	1	12.35	45.83	1.53	0.49	12.36	45.78	2.28	C
Length72	1	12.87	64.57	1.63	0.00	12.87	64.57	0.00	T
Length73	1	12.41	61.66	1.65	0.00	12.41	61.66	0.00	T
Length74	1	12.50	27.28	1.88	0.49	12.51	27.19	2.25	T
Length75	1	11.00	73.82	1.76	1.96	11.17	73.55	10.28	T
Length76	1	12.21	83.83	1.79	0.00	12.21	83.83	0.00	T
Length77	1	13.78	31.77	1.79	1.47	13.85	31.24	6.14	T
Length78	1	13.30	36.01	1.90	0.49	13.31	35.91	2.12	C
Length79	1	10.96	46.77	1.86	1.96	11.13	45.87	10.32	C
Length80	1	9.78	79.43	1.84	1.47	9.89	79.31	8.66	T
Length81	1	13.08	53.81	1.83	0.98	13.12	53.69	4.30	T
Length82	1	12.21	47.56	1.91	0.00	12.21	47.56	0.00	T
Length83	1	8.25	72.57	1.56	0.49	8.26	72.54	3.41	T
Length84	1	13.58	49.32	1.34	0.98	13.62	49.19	4.15	T
Length84	2	12.71	20.29	1.34	3.44	13.16	13.03	15.69	T
Length85	1	11.76	56.56	1.58	0.00	11.76	56.56	0.00	T
Length86	1	11.52	59.01	1.85	0.49	11.53	58.97	2.44	C
Length87	1	11.05	61.78	1.92	3.44	11.57	60.17	18.12	T
Length87	2	12.30	41.99	1.92	0.49	12.31	41.94	2.29	T
Length88	1	9.10	83.16	1.98	0.98	9.15	83.12	6.19	T
Length89	1	11.37	68.47	1.92	0.00	11.37	68.47	0.00	T
Length90	1	10.56	77.63	1.96	1.96	10.74	77.41	10.72	T
Length91	1	12.65	41.73	1.60	0.98	12.69	41.53	4.45	T
Length91	2	9.73	74.83	1.60	0.00	9.73	74.83	0.00	T
Length93	1	11.66	63.73	1.93	0.00	11.66	63.73	0.00	T
Length94	1	11.98	67.58	1.84	3.93	12.61	66.19	19.13	T
Length95	1	12.03	60.54	1.77	2.45	12.28	59.84	11.77	T
Length96	1	12.24	61.65	1.95	0.49	12.24	61.62	2.30	T
Length97	1	11.30	76.52	1.72	0.98	11.34	76.47	4.98	T
Length98	1	13.72	37.03	2.09	1.96	13.86	36.24	8.23	T
Length99	1	10.93	32.74	2.02	2.94	11.32	29.14	15.64	T
Length100	1	13.39	78.03	1.93	4.42	14.10	77.31	19.26	T
Length100	2	10.25	50.78	1.93	1.47	10.36	50.29	8.26	T

SAMPLE: JL06-70										TINT/TI NCLE
Length Name	Length Number	Apparent Length (µm)	Angle to CAxis (°)	Dpar (µm)	Corrected Z Depth (µm)	True Length (µm)	Azimuth (°)	Dip (°)	TINT/TI NCLE	
Length02	1	10.89	23.10	2.59	0.00	10.89	23.10	0.00	T	
Length03	1	10.17	62.55	2.79	0.49	10.18	62.51	2.77	T	
Length04	1	8.46	49.18	3.03	1.47	8.58	48.41	10.03	T	
Length05	1	12.43	77.21	3.04	0.49	12.44	77.20	2.26	T	
Length06	1	11.50	46.84	3.05	0.49	11.51	46.79	2.45	T	
Length08	1	10.55	68.05	2.99	2.45	10.83	67.40	13.46	T	
Length08	2	10.87	69.59	2.99	3.44	11.40	68.44	18.43	T	
Length12	1	13.16	82.05	3.33	1.47	13.24	82.00	6.42	T	
Length13	1	9.02	27.04	2.35	1.96	9.23	24.14	12.57	T	
Length14	1	9.83	83.23	2.51	5.40	11.21	81.89	33.33	C	
Length15	1	9.87	88.93	2.49	2.45	10.17	88.90	14.40	T	
Length16	1	12.32	2.65	2.79	0.49	12.33	1.34	2.28	T	
Length17	1	13.15	36.52	3.02	0.00	13.15	36.52	0.00	T	
Length18	1	14.48	15.17	2.88	1.47	14.56	14.02	5.84	T	
Length18	2	10.88	56.06	2.88	2.45	11.15	55.03	13.03	T	
Length19	1	13.87	57.50	2.85	0.00	13.87	57.50	0.00	T	
Length20	1	9.91	29.95	2.88	2.94	10.34	24.84	17.29	T	
Length21	1	9.99	39.21	2.79	0.98	10.04	38.86	5.64	T	
Length22	1	12.42	74.64	2.87	1.96	12.57	74.44	9.10	T	
Length24	1	11.54	69.62	2.93	0.98	11.58	69.54	4.88	T	
Length25	1	11.11	65.67	2.75	0.49	11.12	65.65	2.53	T	
Length26	1	12.28	54.49	2.86	2.94	12.63	53.25	13.87	T	
Length27	1	12.68	58.98	3.33	0.98	12.72	58.88	4.44	T	
Length28	1	11.58	72.13	3.25	0.49	11.59	72.12	2.43	T	
Length29	1	12.49	57.83	3.16	0.98	12.53	57.72	4.51	T	
Length30	1	12.38	88.15	2.99	0.00	12.38	88.15	0.00	T	
Length30	2	10.77	82.48	2.99	1.47	10.87	82.41	7.85	T	
Length31	1	13.15	46.82	2.46	1.96	13.30	46.21	8.59	T	
Length32	1	9.18	45.00	2.66	2.94	9.65	41.71	18.70	C	
Length34	1	10.27	67.93	3.42	1.47	10.37	67.69	8.25	T	
Length35	1	9.18	37.55	3.20	2.45	9.50	34.64	15.51	T	
Length36	1	12.85	27.74	3.02	0.00	12.85	27.74	0.00	C	
Length38	1	13.11	28.91	2.96	1.96	13.26	27.70	8.61	T	
Length39	1	13.51	33.92	2.80	1.47	13.59	33.40	6.26	T	
Length40	1	11.68	68.55	2.80	2.45	11.93	68.03	12.13	T	
Length41	1	8.98	59.40	2.80	0.98	9.03	59.20	6.28	T	
Length41	2	12.35	72.67	2.80	0.49	12.36	72.66	2.28	T	
Length42	1	12.25	47.31	2.71	0.49	12.26	47.26	2.30	T	
Length43	1	12.54	75.65	2.85	2.94	12.88	75.23	13.58	T	
Length44	1	12.11	79.26	2.50	2.94	12.47	78.92	14.07	T	
Length44	2	9.63	69.37	2.50	3.44	10.22	67.85	20.91	T	
Length45	1	10.56	54.07	2.41	1.47	10.66	53.66	8.02	T	
Length46	1	13.98	63.55	2.77	0.49	13.99	63.54	2.01	T	
Length47	1	12.41	72.21	2.80	0.49	12.42	72.19	2.27	T	
Length48	1	12.81	70.26	2.42	1.47	12.90	70.13	6.60	T	
Length49	1	12.16	50.45	2.51	1.96	12.32	49.82	9.29	T	
Length50	1	9.74	43.13	2.82	0.49	9.75	43.05	2.89	T	
Length51	1	12.76	32.09	2.81	1.96	12.91	30.97	8.85	T	
Length52	1	14.00	64.36	2.58	2.94	14.30	63.73	12.15	T	
Length53	1	12.34	59.88	2.67	0.49	12.35	59.86	2.28	T	
Length55	1	9.72	89.05	2.72	0.49	9.73	89.05	2.90	T	
Length56	1	13.00	63.27	2.76	1.47	13.08	63.08	6.50	T	
Length57	1	12.63	48.59	3.19	0.98	12.67	48.44	4.46	T	
Length58	1	13.12	66.50	2.77	1.47	13.20	66.35	6.44	T	
Length60	1	13.33	74.84	2.80	0.98	13.37	74.80	4.22	T	
Length61	1	11.97	33.39	2.82	0.00	11.97	33.39	0.00	T	
Length62	1	11.97	64.01	3.05	2.45	12.22	63.40	11.83	T	
Length63	1	13.20	47.53	2.95	2.45	13.42	46.59	10.72	T	
Length64	1	13.91	22.53	2.92	1.47	13.99	21.74	6.07	T	
Length65	1	11.80	72.95	2.46	0.00	11.80	72.95	0.00	T	
Length66	1	11.69	50.04	2.84	2.94	12.06	48.42	14.59	T	
Length67	1	10.64	64.10	2.58	1.96	10.82	63.61	10.63	T	
Length68	1	11.11	71.52	2.63	1.96	11.28	71.22	10.18	C	
Length69	1	11.39	37.72	2.88	0.98	11.43	37.44	4.95	T	
Length70	1	12.89	38.78	2.63	2.45	13.12	37.44	10.97	T	
Length70	1	10.66	30.77	2.63	0.00	10.66	30.77	0.00	C	
Length71	1	11.95	86.97	2.39	2.45	12.20	86.90	11.85	T	
Length71	2	11.73	62.50	2.39	4.42	12.53	60.11	22.13	T	
Length72	1	10.56	71.79	2.38	0.98	10.60	71.71	5.34	T	
Length73	1	14.10	49.68	2.15	0.00	14.10	49.68	0.00	T	
Length74	1	12.66	76.83	2.66	0.00	12.66	76.83	0.00	T	
Length75	1	13.91	22.96	2.68	0.49	13.92	22.87	2.02	T	
Length76	1	11.19	77.01	2.59	2.94	11.57	76.53	15.26	T	
Length76	2	10.29	40.58	2.59	0.49	10.30	40.50	2.73	T	
Length77	1	13.11	78.98	2.65	1.96	13.26	78.85	8.61	T	
Length78	1	12.09	68.88	2.75	0.00	12.09	68.88	0.00	T	
Length79	1	8.57	62.75	2.48	0.49	8.58	62.70	3.28	T	
Length79	1	11.33	39.65	2.48	0.00	11.33	39.65	0.00	C	
Length80	1	11.33	47.32	2.75	0.98	11.37	47.12	4.97	T	
Length81	1	13.91	83.93	2.99	0.00	13.91	83.93	0.00	T	
Length82	1	13.58	52.57	3.12	2.45	13.80	51.84	10.41	T	
Length83	1	9.87	71.62	3.07	3.93	10.62	69.90	23.44	T	
Length84	1	12.04	67.34	2.86	1.96	12.20	67.01	9.39	T	
Length85	1	12.51	65.04	2.73	2.45	12.75	64.51	11.31	T	
Length85	2	11.01	69.39	2.73	3.44	11.53	68.25	18.19	T	
Length86	1	12.94	76.68	2.58	0.98	12.98	76.64	4.35	T	
Length87	1	11.87	71.33	2.83	2.45	12.12	70.91	11.93	T	
Length88	1	11.08	83.47	2.59	1.47	11.18	83.41	7.64	T	
Length89	1	11.21	74.17	2.66	0.00	11.21	74.17	0.00	T	
Length90	1	12.31	57.81	2.69	2.45	12.55	57.07	11.50	T	
Length91	1	13.39	37.41	2.90	0.98	13.42	37.21	4.21	T	
Length92	1	11.90	51.87	2.60	6.87	13.74	40.87	35.28	T	
Length93	1	11.57	87.60	2.26	3.93	12.22	87.45	19.84	T	
Length94	1	13.30	59.76	2.74	1.47	13.38	59.55	6.36	C	
Length95	1	8.88	53.91	2.74	2.45	9.21	52.20	16.04	T	
Length96	1	13.33	40.30	2.70	1.47	13.41	39.88	6.34	T	
Length96	1	13.51	44.39	2.70	1.47	13.59	44.03	6.26	C	
Length97	1	12.67	68.10	2.38	4.42	13.42	66.55	20.41	T	
Length98	1	10.12	60.40	2.46	3.93	10.85	57.60	22.83	T	
Length99	1	12.71	79.92	2.75	0.49	12.72	79.92	2.21	T	
Length100	1	10.92	86.84	2.81	2.45	11.19	86.75	12.98	T	

SAMPLE: JL06-73									
Length Name	Length Number	Apparent Length (μm)	Angle to CAxis (°)	Dpar (μm)	Corrected Z Depth (μm)	True Length (μm)	Azimuth (°)	Dip (°)	TINT/TI NCLE
Length01	1	9.44	46.68	3.51	2.45	9.76	44.73	15.06	T
Length02	1	10.03	79.76	3.06	1.47	10.14	79.64	8.44	T
Length02	2	9.72	66.65	3.06	3.93	10.48	64.32	23.82	T
Length03	1	12.62	85.18	2.88	1.47	12.71	85.15	6.70	C
Length03	2	10.74	51.85	2.88	0.49	10.75	51.81	2.62	C
Length04	1	8.68	74.05	3.35	0.49	8.70	74.02	3.24	T
Length05	1	11.49	67.50	2.75	0.49	11.50	67.48	2.45	T
Length05	2	11.24	69.16	2.75	0.00	11.24	69.16	0.00	T
Length05	3	13.80	34.22	2.75	0.98	13.84	34.01	4.08	T
Length07	1	11.98	71.19	3.66	1.47	12.07	71.04	7.06	T
Length08	1	14.61	81.77	3.26	0.49	14.62	81.77	1.92	T
Length08	1	12.93	55.75	3.26	2.94	13.26	54.69	13.16	C
Length09	1	10.51	86.38	3.51	2.45	10.79	86.27	13.51	T
Length10	1	11.43	37.40	3.53	0.49	11.44	37.33	2.46	T
Length12	1	10.80	45.52	3.14	0.49	10.81	45.46	2.60	T
Length13	1	14.07	72.03	3.63	0.49	14.08	72.02	0.00	T
Length14	1	12.24	73.14	3.48	4.42	13.01	71.89	21.15	T
Length17	1	10.94	72.05	3.69	0.00	10.94	72.05	0.00	T
Length18	1	12.78	81.90	3.14	0.00	12.78	81.90	0.00	T
Length19	1	13.13	47.89	3.32	1.96	13.28	47.30	8.60	T
Length19	2	12.52	1.14	3.32	0.00	12.52	1.14	0.00	T
Length20	1	13.62	86.62	3.44	2.45	13.84	86.56	10.38	T
Length21	1	12.77	65.18	2.83	2.45	13.00	64.68	11.08	T
Length22	1	13.05	19.37	2.78	0.49	13.06	19.25	2.15	T
Length23	1	9.36	69.38	3.31	4.42	10.35	66.46	28.17	C
Length24	1	9.07	65.18	3.28	1.96	9.28	64.54	12.49	T
Length25	1	12.05	48.00	3.17	0.00	12.05	48.00	0.00	T
Length26	1	11.76	50.11	2.88	2.45	12.01	49.03	12.04	T
Length27	1	12.36	51.44	3.72	1.47	12.45	51.12	6.84	T
Length27	2	12.14	54.74	3.72	2.45	12.38	53.88	11.67	T
Length29	1	12.75	84.18	3.28	1.47	12.83	84.14	6.63	T
Length31	1	10.90	87.88	2.92	2.94	11.29	87.80	15.67	T
Length32	1	12.29	88.03	3.31	1.47	12.38	88.02	6.88	T
Length33	1	11.39	61.21	2.90	2.45	11.65	60.45	12.44	T
Length34	1	11.09	77.88	2.05	2.45	11.36	77.57	12.78	T
Length37	1	12.03	9.01	2.89	0.00	12.03	9.01	0.00	T
Length38	1	12.21	68.17	2.80	0.49	12.22	68.15	2.30	T
Length39	1	12.16	78.19	2.78	0.49	12.17	78.18	2.31	T
Length40	1	10.56	58.51	3.25	3.93	11.27	55.76	21.82	T
Length41	1	14.33	29.79	3.02	0.49	14.33	29.73	1.96	T
Length42	1	8.89	80.73	3.58	0.98	8.94	80.67	6.34	T
Length43	1	10.68	59.36	3.39	0.98	10.72	59.22	5.28	T
Length44	1	11.98	86.59	3.62	0.98	12.03	86.58	4.70	T
Length45	1	10.29	63.26	3.50	0.98	10.34	63.12	5.47	T
Length47	1	10.98	72.71	3.24	1.96	11.15	72.42	10.30	T
Length48	1	14.58	49.20	2.34	0.98	14.62	49.09	3.86	T
Length49	1	9.64	11.73	2.98	0.98	9.69	10.19	5.84	T
Length49	2	8.90	51.78	2.98	1.96	9.11	50.63	12.75	T
Length50	1	7.16	83.54	2.81	0.00	7.16	83.54	0.00	T
Length51	1	11.23	70.89	2.81	0.00	11.23	70.89	0.00	T
Length52	1	12.76	36.52	3.23	0.00	12.76	36.52	0.00	C
Length53	1	12.14	38.85	3.28	3.93	12.76	34.61	18.87	T
Length54	1	9.43	28.27	3.29	0.49	9.44	28.12	2.98	T
Length55	1	10.19	67.19	2.85	0.49	10.20	67.16	2.76	T
Length56	1	12.45	62.87	2.90	4.91	13.38	60.25	23.22	T
Length57	1	10.77	34.65	3.36	2.94	11.16	31.21	15.87	T
Length58	1	13.57	86.51	3.09	2.45	13.79	86.46	10.42	C
Length60	1	11.62	89.57	2.93	1.96	11.78	89.57	9.73	T
Length62	1	10.32	60.66	2.15	1.47	10.42	60.32	8.20	T
Length63	1	10.41	85.78	2.96	5.89	11.96	84.89	34.44	T
Length64	1	10.25	33.15	2.87	0.98	10.30	32.74	5.49	T
Length65	1	10.89	70.71	2.69	3.93	11.57	69.26	21.14	T
Length66	1	7.47	53.63	2.61	0.00	7.47	53.63	0.00	T
Length69	1	12.28	52.99	2.83	0.00	12.28	52.99	0.00	T
Length70	1	11.93	8.46	2.69	0.49	11.94	8.13	2.36	C
Length71	1	13.23	58.51	2.65	2.45	13.45	57.89	10.69	C
Length72	1	9.97	57.07	2.70	0.00	9.97	57.07	0.00	T
Length74	1	11.88	42.25	3.19	0.98	11.92	42.03	4.74	T
Length75	1	12.80	34.24	3.15	0.00	12.80	34.24	0.00	T
Length75	2	10.34	82.70	3.15	1.47	10.45	82.63	8.19	T
Length76	1	9.89	79.21	3.04	1.96	10.08	78.99	11.45	T
Length77	1	9.36	68.41	2.57	2.45	9.67	67.58	15.21	T
Length78	1	11.27	34.44	2.76	0.49	11.29	34.36	2.49	T
Length79	1	10.60	75.17	2.93	5.40	11.89	72.70	30.63	T
Length80	1	7.60	66.24	2.88	0.49	7.62	66.19	3.70	T
Length80	2	11.16	58.72	2.88	0.00	11.16	58.72	0.00	T
Length80	3	12.18	75.88	2.88	0.00	12.18	75.88	0.00	T
Length81	1	14.23	22.92	2.80	0.00	14.23	22.92	0.00	T
Length82	1	9.93	50.85	3.26	0.49	9.94	50.79	2.83	T
Length83	1	9.78	11.98	3.33	0.00	9.78	11.98	0.00	T
Length84	1	12.68	65.39	3.25	1.47	12.77	65.21	6.67	T
Length84	2	9.98	76.21	3.25	0.49	10.00	76.19	2.82	T
Length85	1	11.11	44.47	3.15	5.89	12.57	32.68	32.02	T
Length86	1	12.60	52.15	3.16	0.49	12.61	52.12	2.23	T
Length86	2	11.49	40.12	3.16	0.98	11.54	39.87	4.90	T
Length88	1	12.84	74.91	2.83	2.45	13.08	74.62	11.01	T
Length89	1	12.93	65.05	2.96	0.49	12.94	65.03	2.17	T
Length90	1	11.54	61.33	3.08	1.47	11.63	61.07	7.33	T
Length91	1	11.90	86.56	3.08	3.44	12.38	86.41	16.78	T
Length92	1	12.66	81.25	3.19	1.47	12.74	81.19	6.68	T
Length94	1	8.02	81.82	2.91	0.49	8.03	81.80	3.51	T
Length95	1	11.23	73.95	2.80	0.98	11.28	73.88	5.01	T
Length96	1	10.31	79.00	3.00	2.94	10.72	78.52	16.60	T
Length97	1	11.89	59.26	2.35	0.98	11.93	59.14	4.74	T
Length98	1	10.04	76.69	2.94	0.00	10.04	76.69	0.00	T

SAMPLE: JL06-90									154
Length Name	Length Number	Apparent Length (μm)	Angle to CAxis (°)	Dpar (μm)	Corrected Z Depth (μm)	True Length (μm)	Azimuth (°)	Dip (°)	TINT/TI NCLE
Length02	1	10.09	66.48	2.28	0.49	10.11	66.45	2.79	T
Length03	1	12.69	57.44	2.18	5.89	13.99	52.59	27.64	T
Length04	1	12.77	70.54	2.26	0.98	12.81	70.48	4.41	T
Length05	1	11.70	65.58	2.26	0.98	11.74	65.48	4.81	T
Length07	1	12.42	58.67	2.78	4.91	13.35	55.52	23.28	T
Length08	1	11.17	82.98	2.68	0.49	11.19	82.97	2.52	T
Length09	1	10.69	87.26	2.28	1.47	10.79	87.24	7.92	T
Length10	1	12.28	23.94	2.16	0.49	12.29	23.84	2.29	T
Length10	2	11.08	37.40	2.16	4.42	11.93	29.99	23.49	T
Length11	1	12.98	34.27	2.44	5.40	14.06	24.66	24.58	T
Length12	1	9.20	22.27	2.44	0.49	9.21	22.07	3.06	T
Length13	1	12.32	67.12	2.37	2.45	12.56	66.62	11.49	T
Length14	1	13.82	66.13	2.42	1.96	13.96	65.87	8.17	T
Length15	1	9.66	34.26	2.68	1.47	9.77	33.25	8.76	T
Length16	1	11.17	71.72	2.41	2.45	11.44	71.25	12.69	T
Length17	1	13.35	83.03	2.36	0.98	13.39	83.01	4.22	T
Length18	1	13.07	59.78	2.26	4.42	13.79	57.67	19.76	T
Length19	1	11.30	80.78	2.27	1.96	11.47	80.63	10.01	T
Length20	1	15.52	73.47	1.77	5.40	16.44	72.33	20.35	C
Length21	1	13.75	70.63	2.23	0.49	13.76	70.62	2.05	T
Length22	1	13.94	53.95	2.26	0.98	13.97	53.85	4.04	T
Length23	1	10.35	31.76	2.26	1.96	10.54	30.00	10.93	T
Length24	1	12.97	89.99	2.44	0.49	12.98	89.99	2.17	T
Length25	1	8.70	62.96	2.66	0.00	8.70	62.96	0.00	T
Length26	1	14.63	53.84	2.27	1.47	14.70	53.62	5.78	T
Length27	1	12.48	76.36	2.39	0.00	12.48	76.36	0.00	T
Length28	1	13.00	50.00	2.31	0.00	13.00	50.00	0.00	T
Length28	2	12.45	82.41	2.31	0.00	12.45	82.41	0.00	T
Length29	1	12.30	78.31	2.14	6.38	13.85	76.29	31.25	T
Length30	1	11.59	80.61	2.46	6.38	13.23	78.73	33.40	C
Length32	1	11.64	66.43	2.61	6.87	13.52	60.30	36.18	T
Length33	1	12.70	25.18	2.27	0.98	12.73	24.81	4.43	T
Length34	1	12.56	19.17	2.04	0.00	12.56	19.17	0.00	T
Length35	1	12.24	52.95	2.27	3.44	12.72	51.12	16.29	T
Length36	1	12.16	47.30	2.61	4.42	12.93	43.29	21.31	T
Length37	1	9.07	71.42	2.27	1.96	9.28	70.95	12.50	T
Length37	2	12.27	31.92	2.27	5.40	13.41	19.05	26.10	T
Length38	1	12.41	69.45	2.34	5.40	13.53	67.05	25.79	T
Length39	1	8.89	30.22	2.28	1.96	9.10	27.63	12.76	T
Length40	1	14.17	28.48	2.49	0.00	14.17	28.48	0.00	T
Length40	2	13.18	74.63	2.49	0.98	13.22	74.58	4.27	T
Length40	3	12.95	38.56	2.49	1.47	13.03	38.09	6.53	T
Length41	1	9.07	51.38	2.45	2.94	9.54	48.71	18.94	T
Length42	1	14.03	69.29	2.78	2.45	14.25	68.95	10.07	T
Length43	1	9.23	21.46	2.81	0.49	9.24	21.25	3.05	T
Length44	1	13.39	67.55	2.66	3.93	13.96	66.46	17.05	T
Length45	1	11.28	69.72	2.38	0.98	11.32	69.64	4.99	T
Length46	1	13.28	73.47	2.28	0.98	13.31	73.43	4.24	T
Length47	1	11.82	87.25	2.29	0.98	11.86	87.24	4.76	T
Length48	1	12.37	55.60	2.36	0.98	12.41	55.47	4.55	T
Length49	1	9.98	25.04	2.30	0.98	10.03	24.44	5.64	T
Length50	1	12.01	27.95	2.53	0.00	12.01	27.95	0.00	T
Length51	1	13.67	64.41	2.59	3.93	14.22	63.19	16.69	T
Length52	1	12.45	65.51	2.96	0.98	12.49	65.43	4.52	T
Length53	1	13.40	77.18	2.87	5.89	14.63	75.70	26.08	T
Length54	1	9.56	69.61	2.96	1.96	9.76	69.15	11.85	T
Length55	1	13.61	89.46	2.35	0.98	13.65	89.45	4.14	T
Length56	1	13.70	71.88	2.44	1.96	13.84	71.68	8.24	T
Length57	1	13.64	34.01	2.44	0.98	13.68	33.79	4.13	T
Length58	1	12.57	86.06	2.45	2.45	12.80	85.98	11.26	T
Length59	1	12.03	48.29	2.70	1.47	12.12	47.90	7.03	T
Length60	1	12.60	78.69	2.70	1.96	12.75	78.55	8.97	T
Length61	1	10.49	60.59	2.62	2.45	10.77	59.67	13.53	T
Length62	1	12.13	57.86	2.71	1.96	12.29	57.38	9.31	T
Length63	1	14.29	40.26	2.26	4.91	15.11	35.65	20.09	T
Length64	1	13.16	43.94	2.26	3.44	13.60	41.76	15.14	T
Length65	1	13.22	80.38	2.66	0.00	13.22	80.38	0.00	T
Length66	1	14.37	41.24	2.73	3.44	14.77	39.24	13.83	T
Length67	1	11.87	49.56	2.56	0.00	11.87	49.56	0.00	T
Length68	1	10.83	66.97	2.51	1.47	10.93	66.75	7.81	C
Length69	1	12.61	58.54	2.47	5.89	13.92	53.83	27.83	T
Length70	1	10.51	72.81	2.10	1.47	10.62	72.64	8.05	T
Length71	1	12.96	78.47	2.28	4.42	13.70	77.73	19.92	C
Length72	1	13.51	48.18	1.95	0.00	13.51	48.18	0.00	C
Length73	1	12.40	87.26	2.08	0.49	12.41	87.26	2.27	T
Length74	1	11.38	46.55	2.00	2.45	11.64	45.23	12.45	T
Length75	1	13.82	86.08	2.00	1.96	13.96	86.04	8.16	T
Length76	1	13.61	44.07	1.99	2.94	13.93	42.61	12.49	T
Length77	1	12.57	28.41	2.10	1.96	12.72	27.06	8.99	T
Length78	1	13.67	39.85	1.96	2.94	13.99	38.17	12.44	T
Length79	1	13.03	54.37	2.67	0.98	13.07	54.26	4.32	T
Length80	1	12.47	77.47	2.52	2.45	12.71	77.22	11.35	T
Length81	1	11.90	46.86	2.28	2.94	12.26	45.11	14.33	T
Length82	1	14.07	52.87	2.44	0.98	14.10	52.76	4.00	T
Length83	1	13.69	86.46	2.35	0.98	13.73	86.46	4.11	T
Length84	1	9.14	50.85	2.54	1.47	9.26	50.23	9.27	T
Length85	1	11.06	66.27	2.49	4.42	11.91	63.96	23.55	T
Length86	1	13.02	86.23	1.85	1.47	13.10	86.21	6.49	T
Length87	1	9.33	42.68	2.12	3.44	9.94	37.75	21.60	T
Length88	1	13.16	84.48	2.33	3.44	13.60	84.29	15.13	T
Length89	1	14.26	46.26	2.45	2.45	14.47	45.42	9.91	T
Length90	1	13.31	74.31	2.30	1.96	13.46	74.13	8.48	T
Length91	1	9.96	74.74	2.34	1.47	10.07	74.57	8.50	T
Length92	1	12.03	45.08	2.42	0.00	12.03	45.08	0.00	T
Length94	1	9.39	79.84	2.34	0.00	9.39	79.84	0.00	T
Length95	1	10.10	33.57	2.22	1.47	10.20	32.62	8.38	T
Length96	1	12.19	37.06	2.30	1.47	12.28	36.50	6.94	T
Length96	2	13.44	64.25	2.30	0.98	13.47	64.18	4.19	T
Length97	1	13.19	86.32	2.32	2.45	13.41	86.26	10.72	T
Length98	1	11.27	55.68	2.18	0.98	11.31	55.53	5.00	T
Length98	2	10.05	23.83	2.18	0.98	10.10	23.20	5.60	T
Length99	1	13.23	42.62	2.18	3.44	13.67	40.36	15.05	T
Length100	1	13.50	81.76	2.18	0.49	13.51	81.76	2.08	T
Length101	1	10.84	76.75	2.42	2.94	11.23	76.22	15.76	T
Length102	1	14.36	66.54	2.26	2.45	14.57	66.17	9.84	T
Length103	1	9.15	21.82	2.26	0.49	9.16	21.61	3.08	T
Length103	2	11.07	34.65	2.26	0.98	11.11	34.32	5.09	T

SAMPLE: DC06-61									
Length Name	Length Number	Apparent Length (μm)	Angle to CAxis (°)	Dpar (μm)	Corrected Z Depth (μm)	True Length (μm)	Azimuth (°)	Dip (°)	TINT/TI NCLE
Length01	1	12.43	8.67	2.59	0.49	12.44	8.37	2.26	T
Length02	1	9.64	53.21	2.88	0.49	9.65	53.16	2.92	T
Length03	1	10.87	60.07	2.62	0.98	10.92	59.93	5.18	C
Length04	1	7.85	55.63	3.14	0.00	7.85	55.63	0.00	T
Length06	1	13.52	32.96	2.96	0.49	13.53	32.90	2.08	T
Length07	1	13.09	42.65	2.41	0.98	13.13	42.47	4.30	T
Length08	1	9.87	18.33	1.79	0.49	9.88	18.12	2.85	T
Length08	2	7.33	27.27	2.54	0.49	7.35	27.02	3.84	T
Length09	1	12.30	48.24	2.61	2.94	12.65	46.69	13.85	T
Length10	1	11.88	33.45	2.53	0.49	11.89	33.38	2.37	T
Length11	1	14.55	47.14	2.64	0.98	14.59	47.02	3.87	T
Length12	1	12.88	58.49	2.37	0.00	12.88	58.49	0.00	T
Length13	1	10.90	84.88	3.00	0.00	10.90	84.88	0.00	T
Length14	1	10.16	85.25	2.49	2.94	10.58	85.04	16.85	T
Length15	1	10.06	28.92	2.88	3.93	10.79	18.05	22.98	T
Length16	1	12.82	48.02	2.65	1.96	12.97	47.40	8.81	T
Length17	1	12.38	55.09	2.61	0.00	12.38	55.09	0.00	T
Length18	1	12.51	59.89	2.96	2.94	12.85	58.92	13.62	T
Length19	1	10.69	52.21	2.49	4.42	11.57	47.71	24.40	T
Length20	1	8.41	38.57	2.54	0.98	8.47	38.08	6.70	T
Length20	2	10.95	86.77	2.54	0.49	10.96	86.77	2.57	T
Length22	1	10.98	75.39	2.46	4.42	11.83	74.01	23.73	T
Length22	2	14.67	35.14	2.46	0.49	14.68	35.09	1.92	T
Length23	1	7.64	9.24	2.46	0.98	7.70	5.57	7.38	T
Length24	1	11.30	58.78	2.49	0.49	11.31	58.75	2.49	T
Length26	1	11.40	66.04	2.69	0.00	11.40	66.04	0.00	T
Length27	1	13.19	51.68	2.80	0.98	13.22	51.55	4.27	T
Length28	1	12.28	70.26	2.53	8.34	14.85	62.60	42.80	T
Length29	1	13.05	89.16	2.44	0.98	13.09	89.16	4.31	C
Length30	1	13.34	8.67	2.20	1.96	13.48	1.90	8.47	T
Length30	2	11.94	40.34	2.20	0.98	11.98	40.11	4.72	T
Length31	1	12.81	20.64	2.51	0.98	12.85	20.19	4.39	C
Length32	1	10.35	55.35	2.54	0.49	10.36	55.30	2.72	C
Length32	2	9.49	39.06	2.54	0.98	9.54	38.68	5.94	C
Length33	1	13.18	80.56	2.62	0.49	13.19	80.56	2.13	T
Length35	1	12.40	61.41	2.96	0.49	12.41	61.38	2.27	T
Length36	1	9.53	84.67	2.48	0.98	9.58	84.65	5.91	T
Length36	2	11.45	80.94	2.48	0.00	11.45	80.94	0.00	T
Length36	3	10.48	42.92	2.48	0.00	10.48	42.92	0.00	T
Length37	1	10.67	56.71	2.41	2.45	10.95	55.67	13.30	T
Length38	1	14.65	23.78	2.78	0.49	14.65	23.70	1.92	T
Length39	1	12.65	62.09	2.78	2.94	12.99	61.23	13.46	T
Length40	1	9.27	19.61	3.05	0.98	9.33	18.68	6.08	T
Length41	1	13.16	65.31	2.39	0.00	13.16	65.31	0.00	T
Length41	2	9.89	27.27	2.39	0.49	9.90	27.14	2.84	T
Length42	1	8.10	73.89	1.82	0.49	8.12	73.86	3.47	T
Length43	1	10.84	34.59	2.56	0.98	10.88	34.24	5.20	T
Length44	1	13.90	59.30	2.45	2.94	14.21	58.51	12.23	T
Length44	2	12.03	39.75	2.45	3.44	12.51	36.66	16.60	T
Length44	3	12.10	89.49	2.45	5.40	13.25	89.43	26.49	T
Length45	1	10.82	58.25	2.39	2.45	11.10	57.30	13.10	T
Length46	1	12.98	33.45	2.42	2.45	13.21	31.82	10.90	T
Length47	1	13.70	89.80	2.54	1.96	13.84	89.79	8.24	T
Length48	1	12.44	79.05	2.42	0.49	12.45	79.04	2.26	T
Length49	1	9.93	39.28	2.20	0.49	9.94	39.20	2.83	T
Length50	1	9.41	14.46	2.66	0.49	9.42	14.15	2.99	T
Length51	1	13.87	66.96	2.30	0.00	13.87	66.96	0.00	T
Length51	2	11.18	27.99	2.30	0.98	11.23	27.57	5.03	T
Length52	1	14.55	45.71	2.73	1.47	14.62	45.42	5.81	T
Length53	1	12.51	84.69	2.28	7.36	14.51	83.43	36.06	T
Length54	1	13.43	89.50	2.30	0.00	13.43	89.50	0.00	C
Length55	1	12.36	72.95	2.85	0.00	12.36	72.95	0.00	T
Length56	1	12.29	70.19	2.49	0.00	12.29	70.19	0.00	C
Length58	1	9.71	70.37	2.92	0.98	9.76	70.26	5.80	T
Length59	1	13.22	48.40	2.15	1.47	13.30	48.08	6.39	T
Length60	1	12.30	58.88	2.46	2.94	12.65	57.84	13.85	T
Length61	1	12.89	41.13	2.23	1.96	13.04	40.35	8.76	C
Length62	1	13.64	74.47	1.91	8.34	15.99	70.22	37.71	T
Length63	1	11.81	58.22	2.70	0.49	11.82	58.19	2.38	T
Length64	1	12.01	66.63	2.44	0.98	12.05	66.55	4.69	T
Length65	1	12.42	80.80	2.44	1.47	12.51	80.73	6.81	C
Length66	1	8.37	64.86	2.54	0.49	8.38	64.82	3.36	T
Length67	1	12.92	51.65	2.70	2.45	13.15	50.80	10.95	T
Length67	2	8.89	31.19	2.70	0.49	8.91	31.05	3.16	T
Length68	1	13.26	17.52	2.61	2.45	13.49	13.99	10.66	T
Length68	2	13.34	51.13	2.61	0.98	13.38	51.01	4.22	T
Length69	1	9.42	52.90	2.85	0.00	9.42	52.90	0.00	T
Length70	1	14.38	55.93	2.53	2.45	14.59	55.35	9.83	T
Length72	1	10.75	30.43	2.38	0.49	10.76	30.33	2.62	T
Length72	2	13.29	50.59	2.38	3.44	13.73	48.91	14.98	T
Length72	3	10.22	73.89	2.38	0.00	10.22	73.89	0.00	T
Length72	4	9.34	44.24	2.38	2.94	9.79	40.98	18.38	T
Length73	1	12.18	41.83	2.54	0.49	12.19	41.77	2.31	T
Length73	2	12.77	75.59	2.54	1.47	12.85	75.49	6.62	T
Length74	1	8.68	88.79	2.33	0.00	8.68	88.79	0.00	T
Length75	1	11.71	76.05	2.75	0.00	11.71	76.05	0.00	T
Length76	1	12.12	65.92	2.67	2.94	12.47	65.13	14.07	T
Length77	1	12.68	83.85	2.28	1.47	12.77	83.81	6.67	T
Length78	1	14.07	64.03	2.22	1.96	14.21	63.75	8.02	T
Length79	1	11.92	22.37	2.51	0.98	11.96	21.89	4.73	T
Length79	2	11.34	34.50	2.51	1.47	11.44	33.79	7.46	T
Length80	1	13.52	79.06	2.40	1.47	13.60	79.00	6.25	T
Length80	2	12.94	48.05	2.40	3.44	13.39	46.10	15.40	T
Length80	3	13.37	19.07	2.40	0.49	13.38	18.95	2.10	T
Length81	1	14.63	81.31	2.41	0.49	14.64	81.30	1.92	T
Length83	1	11.91	61.32	2.18	0.98	11.96	61.21	4.73	T
Length84	1	13.28	58.31	2.51	2.45	13.50	57.69	10.65	T
Length85	1	12.15	80.13	1.95	3.44	12.63	79.70	16.42	T

SAMPLE: DC06-62									
Length Name	Length Number	Apparent Length (μm)	Angle to CAxis (°)	Dpar (μm)	Corrected Z Depth (μm)	True Length (μm)	Azimuth (°)	Dip (°)	TINT/TI NCLE
Length01	1	14.17	44.64	2.63	2.94	14.48	43.33	11.99	C
Length02	1	10.90	57.30	2.42	2.45	11.17	56.32	13.01	T
Length03	1	14.50	61.84	2.16	2.45	14.70	61.39	9.75	T
Length04	1	13.36	48.45	2.35	2.45	13.58	47.57	10.59	T
Length05	1	13.13	72.26	2.61	1.96	13.28	72.05	8.60	T
Length06	1	13.56	47.20	1.93	0.00	13.56	47.20	0.00	T
Length07	1	11.70	72.91	2.49	0.49	11.71	72.90	2.40	T
Length08	1	11.43	51.94	2.54	1.96	11.60	51.26	9.89	T
Length09	1	8.63	81.77	2.75	1.96	8.85	81.55	13.14	T
Length10	1	11.89	85.95	2.31	0.49	11.90	85.95	2.37	T
Length11	1	8.95	37.32	2.06	0.49	8.97	37.21	3.14	T
Length12	1	13.41	51.02	2.06	0.49	13.42	50.98	2.10	T
Length12	2	12.22	54.97	2.06	2.94	12.57	53.74	13.94	T
Length13	1	13.60	71.93	2.38	2.94	13.92	71.47	12.50	T
Length14	1	13.22	49.55	2.37	4.42	13.94	46.51	19.51	T
Length15	1	13.56	58.42	2.08	1.96	13.71	58.04	8.32	T
Length16	1	12.43	61.82	2.46	1.47	12.52	61.60	6.80	T
Length17	1	11.29	61.83	2.61	0.49	11.30	61.80	2.49	T
Length18	1	12.74	73.18	2.14	5.40	13.84	71.37	25.08	T
Length19	1	13.29	38.81	2.16	0.49	13.30	38.76	2.12	T
Length20	1	11.44	66.06	2.16	0.98	11.48	65.96	4.92	T
Length21	1	13.51	51.32	2.31	1.47	13.59	51.04	6.26	T
Length22	1	12.69	71.18	2.41	3.44	13.15	70.42	15.70	T
Length23	1	10.88	83.99	2.37	1.96	11.06	83.89	10.39	T
Length24	1	12.25	44.86	2.26	2.45	12.49	43.65	11.56	T
Length25	1	12.42	40.55	2.45	3.44	12.89	37.75	16.06	T
Length26	1	13.17	79.92	2.13	1.96	13.32	79.81	8.57	T
Length27	1	12.08	79.62	2.16	0.49	12.09	79.61	2.33	T
Length27	2	13.36	12.87	2.16	1.47	13.44	11.23	6.33	T
Length27	3	12.13	30.29	2.16	2.94	12.48	27.11	14.05	T
Length28	1	13.69	47.85	2.05	0.49	13.69	47.82	2.06	T
Length29	1	11.13	81.60	2.09	1.47	11.23	81.53	7.60	T
Length30	1	12.74	80.97	2.34	7.36	14.72	78.91	35.29	T
Length30	2	13.48	33.93	2.34	1.47	13.56	33.41	6.27	T
Length31	1	12.98	64.80	1.83	0.49	12.99	64.78	2.17	T
Length32	1	12.35	67.76	2.04	3.44	12.82	66.80	16.15	T
Length33	1	12.88	81.58	2.36	1.47	12.96	81.63	6.56	T
Length34	1	12.93	86.87	2.30	1.96	14.07	86.84	8.10	T
Length36	1	13.07	78.89	2.45	1.96	12.23	78.74	9.36	T
Length37	1	13.63	62.97	2.18	0.98	13.66	62.89	4.13	C
Length38	1	13.66	76.30	2.43	1.96	13.23	76.14	8.63	T
Length39	1	12.85	79.52	2.14	0.98	12.89	79.48	4.38	T
Length40	1	12.49	76.49	1.91	1.47	12.57	76.40	6.77	T
Length41	1	9.51	45.58	2.13	0.49	9.52	45.50	2.96	T
Length42	1	13.76	46.52	1.95	0.00	13.76	46.52	0.00	T
Length43	1	12.48	89.24	1.95	0.49	12.49	89.24	2.25	C
Length43	2	12.31	88.86	1.95	0.00	12.31	88.86	0.00	C
Length44	1	12.37	30.34	1.78	0.49	12.38	30.26	2.27	T
Length45	1	11.99	79.98	1.97	2.45	12.24	79.76	11.81	T
Length46	1	13.07	45.22	1.93	2.45	13.30	44.18	10.82	T
Length47	1	12.36	44.74	2.04	1.47	12.45	44.33	6.84	T
Length49	1	12.38	49.24	2.35	0.49	12.39	49.21	2.27	T
Length50	1	9.56	56.29	2.18	2.45	9.87	54.96	14.87	T
Length51	1	14.36	14.99	2.22	1.47	14.44	13.82	5.88	T
Length52	1	11.20	67.50	2.00	1.47	11.29	67.30	7.56	T
Length52	2	9.98	88.84	2.00	1.47	10.08	88.83	8.49	T
Length53	1	12.65	64.20	2.18	0.00	12.65	64.20	0.00	T
Length53	2	10.26	81.75	2.18	0.98	10.31	81.71	5.49	T
Length55	1	11.66	51.07	2.36	0.49	11.67	51.03	2.41	T
Length56	1	13.35	64.45	2.01	1.96	13.49	64.15	8.46	T
Length57	1	12.78	75.89	2.62	1.96	12.93	75.72	8.84	T
Length58	1	12.23	51.34	2.30	2.45	12.48	50.38	11.57	T
Length59	1	13.25	42.97	2.22	1.96	13.39	42.28	8.52	T
Length60	1	10.79	53.47	2.12	0.00	10.79	53.47	0.00	T
Length61	1	13.55	28.16	2.03	0.00	13.55	28.16	0.00	T
Length62	1	8.51	75.95	2.05	0.00	8.51	75.95	0.00	T
Length63	1	12.12	69.27	2.09	1.96	12.28	68.97	9.32	C
Length64	1	13.39	70.12	2.62	0.98	13.43	70.06	4.20	T
Length65	1	14.17	45.90	2.84	3.44	14.58	44.14	16.03	T
Length66	1	11.73	52.09	1.54	0.49	11.74	52.05	2.40	T
Length67	1	12.12	88.08	2.03	1.96	12.28	88.05	9.32	C
Length69	1	11.86	63.52	2.17	2.94	12.22	62.60	14.38	T
Length70	1	14.52	68.59	2.05	2.45	14.73	68.26	9.73	T
Length71	1	11.66	63.01	1.63	0.00	11.66	63.01	0.00	T
Length72	1	12.38	66.24	2.11	0.49	12.39	66.22	2.27	T
Length74	1	9.25	72.84	1.88	1.47	9.37	72.51	9.15	T
Length75	1	11.76	56.16	2.26	3.93	12.40	53.79	19.50	T
Length77	1	11.82	74.61	2.18	0.00	11.82	74.61	0.00	T
Length78	1	13.55	65.33	2.46	1.47	13.63	65.18	6.24	C
Length80	1	13.87	59.56	2.24	0.00	13.87	59.56	0.00	T
Length81	1	12.70	82.18	2.31	1.96	12.85	82.09	8.90	T
Length82	1	10.79	46.40	2.12	1.96	10.97	45.47	10.48	T
Length83	1	12.61	43.06	1.96	0.98	12.65	42.87	4.46	T
Length84	1	13.33	79.21	2.18	0.00	13.33	79.21	0.00	C
Length85	1	11.64	72.66	2.37	0.98	11.69	72.60	4.84	T
Length86	1	13.16	81.33	2.33	0.49	13.17	81.33	2.14	T
Length87	1	13.26	63.10	1.89	0.49	13.27	63.08	2.12	C
Length88	1	11.16	85.63	1.96	1.47	11.26	85.59	7.58	C
Length89	1	12.45	44.85	2.42	0.49	12.46	44.80	2.26	T
Length89	2	12.64	52.76	2.42	1.47	12.72	52.47	6.69	T
Length90	1	12.05	51.67	2.21	0.00	12.05	51.67	0.00	T
Length91	1	11.75	66.28	1.95	1.47	11.84	66.08	7.20	T
Length92	1	11.49	88.44	2.14	0.00	11.49	88.44	0.00	T
Length93	1	11.71	67.34	2.09	0.98	11.75	67.25	4.81	T
Length94	1	14.53	47.59	2.26	0.49	14.54	47.57	1.94	T
Length95	1	10.95	72.43	2.44	0.00	10.95	72.43	0.00	T
Length96	1	13.29	52.91	2.47	0.98	13.33	52.79	4.24	T
Length96	2	13.34	59.14	2.47	1.47	13.42	58.93	6.34	T
Length97	1	12.97	69.11	2.55	0.98	13.01	69.05	4.34	T
Length97	2	11.91	79.71	2.55	1.96	12.07	79.56	9.49	T
Length98	1	13.09	72.10	2.29	0.49	13.10	72.09	2.15	C
Length99	1	11.72	76.84	2.42	1.47	11.81	76.74	7.22	T
Length99	2	14.46	64.65	2.42	1.96	14.59	64.40	7.80	T
Length100	1	13.57	54.10	2.45	2.45	13.79	53.40	10.42	T
Length101	1	13.37	69.53	2.32	1.47	13.45	69.40	6.32	T
Length102	1	11.46	60.38	2.09	0.98	11.50	60.26	4.91	T
Length103	1	11.19	73.28	1.80	0.49	11.20	73.26	2.51	T
Length104	1	12.95	51.00	2.48	0.00	12.95	51.00	0.00	T
Length105	1	14.21	51.47	2.66	0.49	14.22	51.45	1.98	C

SAMPLE: VI2001									
Length Name	Length Number	Apparent Length (µm)	Angle to CAxis (°)	Dpar (µm)	Corrected Z Depth (µm)	True Length (µm)	Azimuth (°)	Dip (°)	TINT/TI NCLE
Length01	1	10.57	21.17	2.63	1.96	10.76	18.38	10.70	T
Length02	1	13.47	72.95	2.81	2.94	13.79	72.51	12.63	T
Length03	1	8.48	55.58	2.92	0.00	8.48	55.58	0.00	T
Length04	1	10.95	66.35	2.74	2.45	11.22	65.69	12.96	T
Length05	1	11.74	42.06	3.20	2.45	12.00	40.60	12.06	T
Length06	1	11.78	65.61	3.16	4.91	12.76	62.98	24.63	T
Length07	1	14.55	86.30	2.90	2.45	14.75	86.24	9.71	T
Length08	1	13.40	62.12	3.02	2.45	13.62	61.60	10.55	T
Length09	1	12.51	14.78	2.83	2.94	12.85	5.81	13.61	T
Length10	1	14.66	37.59	2.53	1.47	14.73	37.21	5.77	T
Length11	1	12.50	53.74	2.62	2.94	12.84	52.51	13.63	T
Length12	1	10.15	73.87	2.62	0.98	10.20	73.79	5.55	C
Length13	1	13.45	84.15	2.71	0.98	13.49	84.13	4.18	T
Length14	1	13.75	62.10	3.16	0.98	13.79	62.02	4.09	T
Length15	1	14.07	24.86	3.24	0.49	14.08	24.78	2.00	T
Length16	1	11.94	60.61	2.57	1.47	12.03	60.36	7.08	T
Length17	1	13.08	73.49	3.02	1.47	13.16	73.38	6.46	C
Length18	1	10.15	81.80	2.80	2.45	10.44	81.55	13.99	T
Length19	1	14.35	80.87	2.71	1.47	14.42	80.82	5.89	T
Length19	2	11.14	86.20	2.71	0.98	11.18	86.19	5.05	T
Length20	1	13.04	74.27	3.04	0.98	13.08	74.22	4.32	T
Length21	1	10.46	84.27	2.88	0.00	10.46	84.27	0.00	T
Length22	1	14.31	26.88	3.23	2.94	14.61	24.29	11.87	T
Length23	1	10.27	79.75	3.06	0.98	10.32	79.70	5.48	T
Length24	1	9.93	59.79	3.21	0.49	9.94	59.75	2.83	T
Length24	2	13.25	36.44	3.21	2.45	13.47	35.05	10.68	T
Length24	3	13.58	16.21	3.21	1.47	13.66	14.99	6.22	T
Length24	4	8.77	50.45	3.21	0.49	8.79	50.38	3.21	T
Length25	1	12.70	59.50	3.31	0.00	12.70	59.50	0.00	T
Length26	1	14.77	47.74	3.19	0.00	14.77	47.74	0.00	T
Length27	1	12.39	38.87	2.74	1.96	12.55	37.96	9.11	T
Length28	1	10.04	49.60	2.70	1.47	10.15	49.07	8.43	T
Length29	1	12.41	31.11	2.82	0.00	12.41	31.11	0.00	T
Length29	2	12.31	72.86	2.82	2.45	12.55	72.49	11.50	T
Length30	1	13.17	47.42	2.85	0.00	13.17	47.42	0.00	C
Length31	1	12.32	62.65	3.74	3.93	12.93	61.00	18.59	C
Length32	1	13.43	59.71	3.16	6.87	15.08	54.05	30.78	T
Length33	1	13.50	81.40	2.98	3.44	13.93	81.11	14.74	T
Length35	1	11.37	71.76	3.00	5.89	12.80	68.53	31.20	T
Length36	1	13.63	42.10	2.85	0.49	13.64	42.06	2.06	T
Length36	1	14.28	49.06	2.85	1.47	14.35	48.79	5.92	C
Length37	1	14.08	54.76	3.17	1.47	14.16	54.53	6.00	C
Length38	1	14.43	87.20	2.99	4.91	15.25	87.02	19.88	C
Length39	1	12.09	58.17	2.86	0.98	12.13	58.05	4.66	T
Length40	1	11.08	86.36	3.32	3.93	11.76	86.11	20.75	T
Length42	1	10.19	62.29	3.00	0.98	10.24	62.15	5.53	T
Length43	1	12.89	71.67	3.05	2.94	13.22	71.15	13.21	T
Length44	1	9.41	76.87	2.89	0.98	9.46	76.80	5.99	C
Length45	1	11.92	56.28	2.82	1.96	12.08	55.75	9.48	T
Length46	1	12.86	72.69	3.23	2.45	13.09	72.35	11.01	T
Length47	1	14.02	86.33	3.05	0.00	14.02	86.33	0.00	T
Length48	1	14.67	22.10	3.23	3.44	15.07	17.63	13.54	T
Length49	1	13.13	78.72	3.32	1.96	13.28	78.59	8.60	T
Length50	1	11.19	57.52	3.19	1.96	11.36	56.94	10.10	T
Length51	1	8.42	60.50	3.21	0.00	8.42	60.50	0.00	T
Length52	1	14.85	62.87	3.48	0.49	14.86	62.85	1.89	T
Length53	1	14.91	33.57	3.38	0.49	14.92	33.52	1.89	T
Length54	1	13.89	37.01	3.12	0.49	13.89	36.97	2.03	T
Length55	1	14.88	80.75	3.12	2.45	15.08	80.62	9.49	T
Length56	1	12.01	62.11	3.18	0.49	12.02	62.08	2.34	T
Length57	1	11.61	39.39	3.42	4.42	12.42	33.32	22.36	T
Length58	1	13.27	89.30	2.96	1.47	13.36	89.29	6.37	T
Length60	1	14.25	61.44	3.10	2.94	14.55	60.75	11.93	T
Length61	1	12.42	87.46	2.75	5.40	13.54	87.18	25.77	T
Length62	1	13.85	56.72	3.05	0.00	13.85	56.72	0.00	T
Length63	1	9.21	83.20	2.81	0.98	9.26	83.16	6.12	T
Length64	1	14.47	72.21	3.03	0.98	14.50	72.17	3.89	T
Length65	1	12.61	66.53	3.11	0.00	12.61	66.53	0.00	T
Length66	1	13.14	87.70	3.21	2.94	13.46	87.64	12.96	T
Length66	2	14.78	26.19	3.21	1.96	14.91	25.13	7.63	T
Length67	1	13.16	75.19	3.00	0.49	13.17	75.18	2.14	T
Length68	1	9.81	59.28	3.21	3.44	10.40	56.95	20.49	T
Length69	1	12.09	58.84	2.98	3.93	12.71	56.83	18.96	T
Length70	1	11.04	49.81	2.94	0.00	11.04	49.81	0.00	T
Length71	1	12.62	83.79	3.10	2.45	12.86	83.67	11.21	T
Length72	1	11.60	64.95	3.31	0.49	11.62	64.93	2.42	T
Length73	1	13.58	72.01	2.63	4.91	14.44	70.66	21.18	T
Length74	1	11.97	35.83	3.27	0.00	11.97	35.83	0.00	T
Length75	1	12.03	28.67	3.08	1.47	12.12	27.87	7.03	T
Length76	1	9.63	70.89	2.96	1.47	9.74	70.65	8.79	T
Length77	1	13.32	31.74	3.02	0.49	13.33	31.68	2.11	T
Length78	1	11.29	67.76	2.80	2.45	11.56	67.18	12.55	T
Length79	1	11.38	88.38	3.03	1.96	11.55	88.35	9.94	T
Length80	1	14.09	78.56	2.88	4.42	14.77	77.94	18.27	T
Length81	1	14.35	87.41	2.80	5.89	15.51	87.16	24.23	T
Length82	1	13.80	88.63	3.20	2.45	14.02	88.61	10.24	T
Length83	1	12.25	55.32	3.04	2.45	12.50	54.50	11.55	T
Length84	1	11.67	82.85	3.27	0.49	11.68	82.84	2.41	T
Length85	1	14.24	48.87	2.62	0.00	14.24	48.87	0.00	T
Length86	1	11.58	70.45	2.72	0.98	11.62	70.37	4.86	T
Length87	1	12.45	80.02	2.63	5.89	13.77	78.65	28.24	T
Length88	1	14.40	76.93	3.24	0.49	14.41	76.92	1.95	T
Length89	1	12.48	89.05	2.89	2.45	12.72	89.03	11.34	T

SAMPLE: VI2002										TS
Length Name	Length Number	Apparent Length (µm)	Angle to CAxis (°)	Dpar (µm)	Corrected Z Depth (µm)	True Length (µm)	Azimuth (°)	Dip (°)	TINT/TI NCLE	
Length01	1	12.97	84.58	2.57	0.49	12.98	84.58	2.17	T	
Length02	1	9.87	64.66	2.19	0.98	9.92	64.52	5.71	T	
Length04	1	13.70	72.02	2.10	2.94	14.01	71.57	12.41	T	
Length05	1	12.99	66.67	1.97	3.44	13.44	65.76	15.33	T	
Length05	2	11.12	49.25	1.97	3.93	11.79	45.76	20.67	T	
Length06	1	13.65	60.56	2.50	6.38	15.07	56.22	27.87	T	
Length07	1	10.49	75.97	2.14	1.47	10.59	75.83	8.07	T	
Length07	1	9.73	6.21	2.14	0.49	9.74	5.49	2.89	C	
Length08	1	11.96	50.22	2.63	0.98	12.00	50.05	4.71	T	
Length09	1	12.71	85.61	2.53	3.93	13.31	85.39	17.99	T	
Length10	1	14.16	35.01	2.46	1.96	14.30	34.21	7.97	T	
Length11	1	11.14	39.91	2.61	1.96	11.32	38.80	10.15	T	
Length12	1	14.84	64.07	2.46	0.49	14.85	64.05	1.90	T	
Length13	1	12.01	59.91	2.58	1.47	12.10	59.66	7.04	T	
Length13	2	9.37	79.07	2.58	0.98	9.42	79.00	6.02	T	
Length14	1	11.99	79.35	2.83	1.47	12.08	79.27	7.06	C	
Length15	1	13.08	59.79	2.49	2.45	13.31	59.19	10.81	T	
Length16	1	13.43	67.26	2.61	1.47	13.51	67.12	6.30	T	
Length16	1	8.60	36.81	2.61	0.00	8.60	36.81	0.00	C	
Length17	1	12.41	68.37	2.45	1.96	12.56	68.08	9.11	T	
Length17	2	11.54	63.84	2.45	0.98	11.58	63.74	4.88	T	
Length18	1	13.49	50.81	2.60	0.49	13.50	50.78	2.08	T	
Length19	1	13.16	76.62	2.39	5.89	14.42	75.00	26.59	T	
Length20	1	13.42	68.71	2.44	3.44	13.85	67.94	14.83	T	
Length21	1	14.02	85.76	2.39	1.47	14.10	85.74	6.03	T	
Length22	1	11.68	26.93	2.79	1.96	11.85	25.26	9.67	T	
Length23	1	10.84	61.67	2.59	1.96	11.01	61.15	10.44	T	
Length24	1	13.01	49.26	2.44	0.49	13.02	49.23	2.16	T	
Length26	1	9.61	41.22	2.63	0.49	9.63	41.14	2.93	T	
Length27	1	11.16	66.92	2.63	0.98	11.20	66.82	5.05	T	
Length28	1	13.88	86.26	2.05	0.49	13.88	86.26	2.03	T	
Length29	1	13.47	23.92	2.81	0.98	13.50	23.57	4.18	T	
Length30	1	13.57	54.29	2.56	5.89	14.79	49.61	25.73	T	
Length31	1	13.19	83.49	2.78	0.98	13.22	83.47	4.27	T	
Length32	1	11.81	89.57	2.14	0.98	11.85	89.57	4.77	T	
Length33	1	11.79	36.70	2.37	0.00	11.79	36.70	0.00	T	
Length34	1	13.37	32.62	2.45	3.93	13.94	28.22	17.07	T	
Length36	1	11.32	75.92	2.38	3.44	11.83	75.21	17.66	T	
Length37	1	14.04	66.16	2.63	0.98	14.08	66.10	4.01	T	
Length38	1	13.06	29.65	2.63	2.45	13.29	27.77	10.83	T	
Length39	1	12.79	72.09	2.31	0.98	12.83	72.03	4.44	T	
Length40	1	10.29	55.30	2.34	1.47	10.40	54.89	8.22	T	
Length41	1	12.73	59.78	2.62	3.44	13.19	58.49	15.66	T	
Length42	1	13.02	59.98	2.45	2.45	13.25	59.38	10.86	T	
Length43	1	11.43	58.60	2.52	0.49	11.44	58.57	2.46	T	
Length44	1	14.19	59.84	2.40	2.45	14.40	59.33	9.96	T	
Length45	1	13.44	86.21	2.65	3.93	14.00	86.03	16.99	T	
Length46	1	11.89	51.64	2.44	4.91	12.86	47.05	24.38	T	
Length47	1	10.25	59.14	2.42	0.98	10.30	58.99	5.50	T	
Length47	2	10.29	64.98	2.42	2.94	10.70	63.81	16.64	T	
Length48	1	14.28	76.55	2.45	2.94	14.58	76.25	11.90	T	
Length48	2	12.97	27.90	2.45	0.49	12.98	27.82	2.17	T	
Length49	1	13.60	43.56	2.54	2.94	13.92	42.08	12.50	T	
Length50	1	10.07	61.56	2.59	1.96	10.26	60.96	11.24	T	
Length51	1	13.18	53.26	2.79	0.49	11.39	53.22	2.46	T	
Length51	2	10.15	27.72	2.79	0.98	10.20	27.21	5.55	T	
Length52	1	13.91	55.47	2.43	1.47	13.99	55.25	6.08	T	
Length52	2	12.63	34.23	2.43	0.49	12.64	34.17	2.23	T	
Length53	1	14.10	51.24	2.48	2.94	14.40	50.19	12.06	T	
Length54	1	14.43	31.27	2.67	1.96	14.56	30.37	7.82	T	
Length55	1	13.51	82.25	2.60	0.00	13.51	82.25	0.00	C	
Length56	1	13.34	65.89	2.82	2.94	13.66	65.24	12.75	T	
Length57	1	13.97	65.63	2.35	0.00	13.97	65.63	0.00	T	
Length58	1	11.72	47.87	2.53	2.94	12.08	46.13	14.55	T	
Length59	1	13.71	57.56	2.47	1.96	13.85	57.18	8.23	T	
Length60	1	13.35	67.38	2.65	2.45	13.57	66.97	10.60	T	
Length61	1	12.89	55.94	2.79	2.94	13.22	54.88	13.20	T	
Length61	2	7.29	48.99	2.79	0.49	7.31	48.88	3.86	T	
Length62	1	12.31	85.39	2.05	0.98	12.35	85.37	4.57	T	
Length64	1	12.45	73.19	2.49	0.98	12.49	73.13	4.52	T	
Length65	1	12.87	85.01	2.46	2.94	13.20	84.87	13.23	T	
Length67	1	10.33	78.33	2.26	1.47	10.43	78.21	8.20	T	
Length68	1	11.73	76.25	2.65	6.38	13.35	73.55	32.95	T	
Length68	2	13.45	48.38	2.65	2.94	13.77	47.11	12.65	T	
Length69	1	13.56	71.57	2.77	0.49	13.57	71.55	2.07	T	
Length70	1	14.18	65.17	2.72	6.38	15.55	61.95	26.75	T	
Length71	1	11.96	71.74	2.88	1.96	12.12	71.48	9.44	T	
Length72	1	11.84	49.85	2.80	0.00	11.84	49.85	0.00	T	
Length73	1	13.28	76.54	2.54	1.96	13.43	56.32	8.50	T	
Length74	1	13.11	64.35	2.42	2.45	13.34	63.85	10.79	T	
Length75	1	13.23	71.67	2.34	0.00	13.23	71.67	0.00	T	
Length76	1	12.27	75.06	2.62	1.47	12.36	74.95	6.89	T	
Length77	1	12.67	52.48	2.94	0.49	12.68	52.45	2.22	T	
Length78	1	13.04	60.89	2.12	0.98	13.08	60.80	4.35	T	
Length79	1	13.48	55.58	2.44	1.47	13.56	55.35	6.27	T	
Length80	1	13.62	68.55	2.37	0.49	13.63	68.53	2.06	T	
Length81	1	12.64	55.74	2.85	1.96	12.80	55.26	8.93	T	
Length82	1	14.22	69.98	2.70	1.96	14.36	69.78	7.93	T	
Length83	1	10.40	53.19	2.30	1.47	10.50	52.75	8.14	T	
Length84	1	12.94	80.48	2.69	3.44	13.39	80.12	15.40	T	
Length85	1	13.27	87.26	2.45	0.98	13.31	87.26	4.24	T	
Length86	1	12.01	69.16	2.34	1.96	12.17	68.86	9.41	T	
Length87	1	13.61	65.70	2.10	0.00	13.61	65.70	0.00	T	
Length88	1	13.70	42.84	2.59	0.49	13.71	42.80	2.05	T	
Length89	1	13.19	80.44	2.84	1.47	13.28	80.38	6.41	T	
Length90	1	12.93	48.11	2.11	0.00	12.93	48.11	0.00	T	
Length91	1	14.17	39.97	2.80	0.98	14.21	39.80	3.97	T	
Length92	1	10.81	51.04	2.90	0.00	10.81	51.04	0.00	T	
Length93	1	13.62	68.56	2.49	0.49	13.63	68.55	2.07	T	
Length94	1	13.51	87.69	2.81	0.00	13.51	87.69	0.00	T	
Length95	1	13.38	51.45	2.79	0.00	13.38	51.45	0.00	T	
Length96	1	13.77	80.84	2.46	0.49	13.78	80.84	2.04	T	
Length97	1	13.38	63.69	2.67	3.44	13.82	62.71	14.88	T	
Length97	2	10.81	25.89	2.67	0.49	10.82	25.77	2.66	T	
Length98	1	12.17	28.25	3.13	1.96	12.32	26.80	9.29	T	
Length99	1	11.92	35.95	2.96	0.98	11.96	35.68	4.72	T	
Length100	1	13.82	51.13	2.68	0.49	13.83	51.10	2.03	C	
Length101	1	14.27	58.04	2.02	0.49	14.27	58.02	1.97	T	
Length102	1	14.56	26.62	2.29	0.00	14.56	26.62	0.00	T	
Length103	1	12.83	54.27	2.25	0.00	12.83	54.27	0.00	T	
Length104	1	13.67	81.36	2.65	0.49	13.67	81.36	2.06	T	
Length105	1	13.44	68.21	2.52	1.47	13.52	68.07	6.29	T	

Table A.4: QTQt modelling parameters used in this study, results seen in Figure A.5.

Sample ID	FT/He /Both	AFT input*	AHe input*	Track length input [†]	Con. General Prior [§]	Con. Box 2 [#]	Burn-in/Post Burn-in
JL06-46	Both	34	8	95	75±75 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000
JL06-49	Both	13	5	7	100±100 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000
JL06-51	Both	30	8	95	65±65 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000
JL06-56	Both	25	4	90	85±85 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000
JL06-58	Both	32	5	100	90±90 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000
JL06-64	Both	29	5	114	45±45 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000
JL06-70	Both	38	5	101	65±65 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000
JL06-73	Both	33	5	95	80±80 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000
JL06-90	Both	37	5	107	50±50 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000
DC06-61	Both	21	4	98	65±65 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000
DC06-62	Both	26	5	109	70±70 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000
VI2001	Both	27	5	93	75±75 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000
VI2002	Both	18	4	112	80±80 m.y., 70±70°C	180±20 m.y., 850±50°C	50000 / 100000

Note: Modeling of all samples uses radiation damage model of Gautheron et al (2009) and fission track annealing model of Ketcham et al (2007). Dpar data is used as the compositional model, and etchant is 5.5 mol. Present-day temperature is assumed as 10 ± 10 °C.

*Number of input AFT count or AHe data.

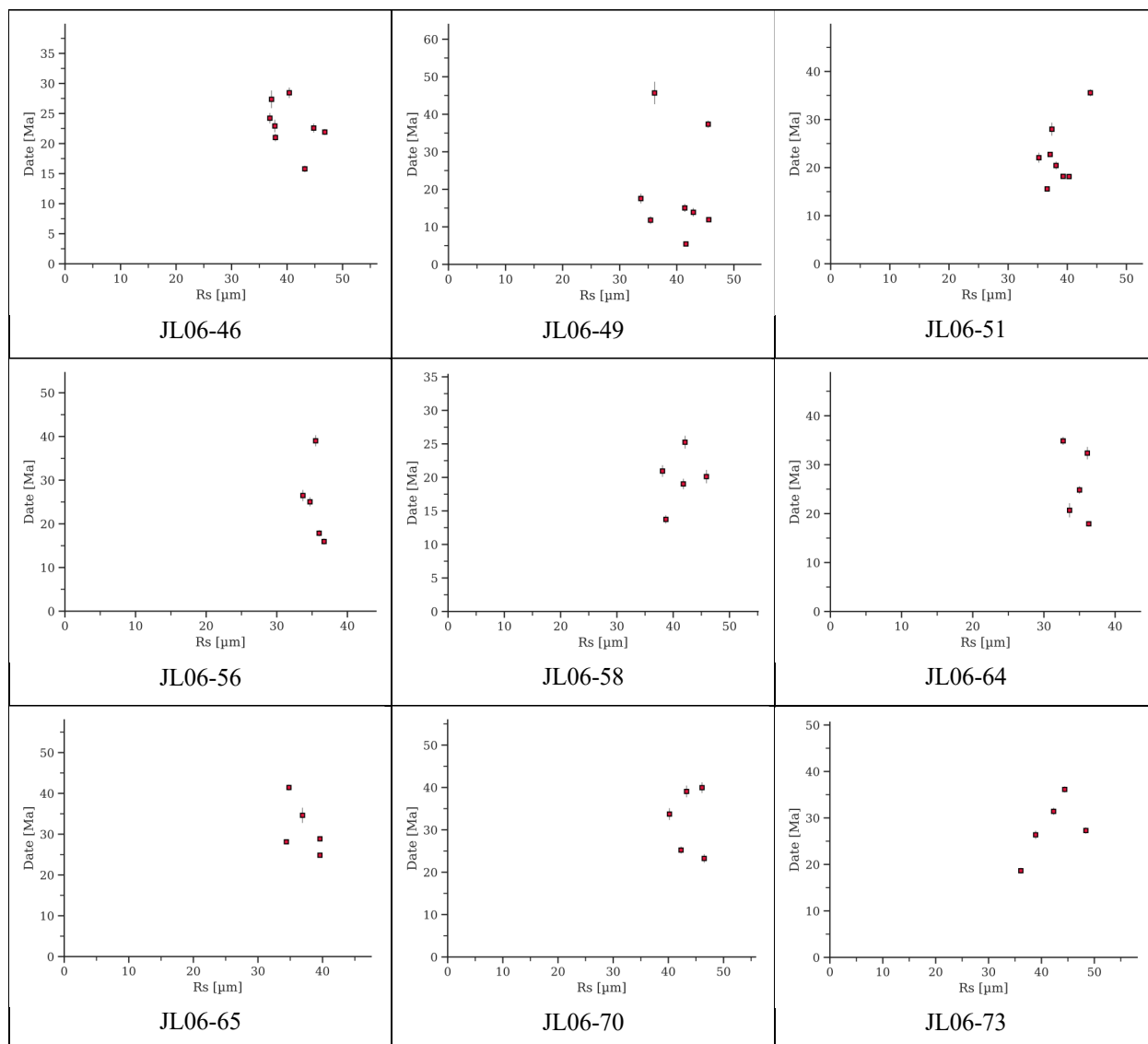
[†]Number of input track length data for a sample.

[§]Constraint box of general prior, encompassing all AFT and AHe ages.

[#]The second constraint box is set according to the UPb ages of the bedrock in the study region.

A.2 Appendix A Figures

Figure A.1: Rs vs date plots for single grain AHe data. Rs - radius of a sphere with an equivalent alpha-ejection correction as the grain, calculated using Ketcham et al. (2011).



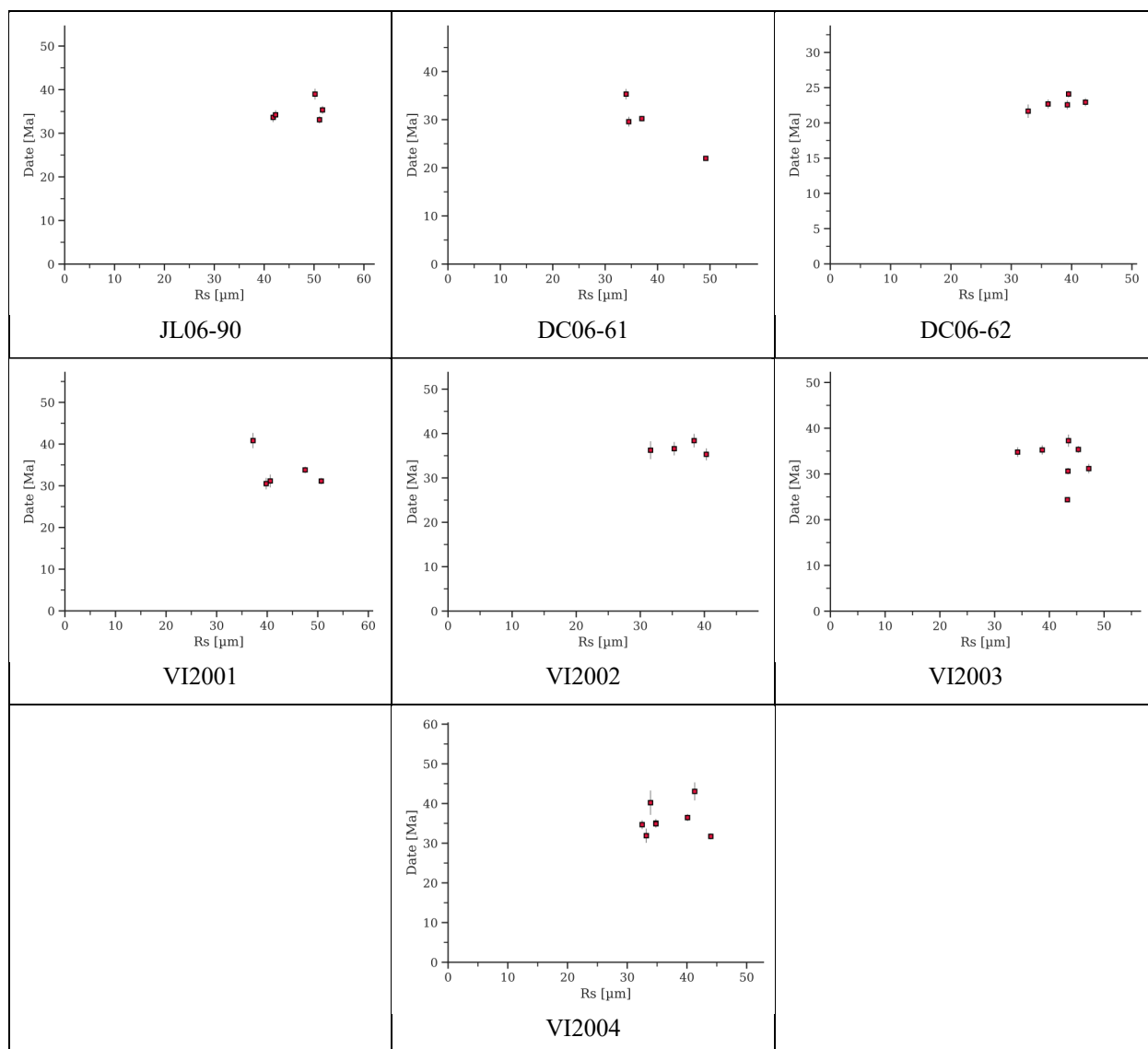
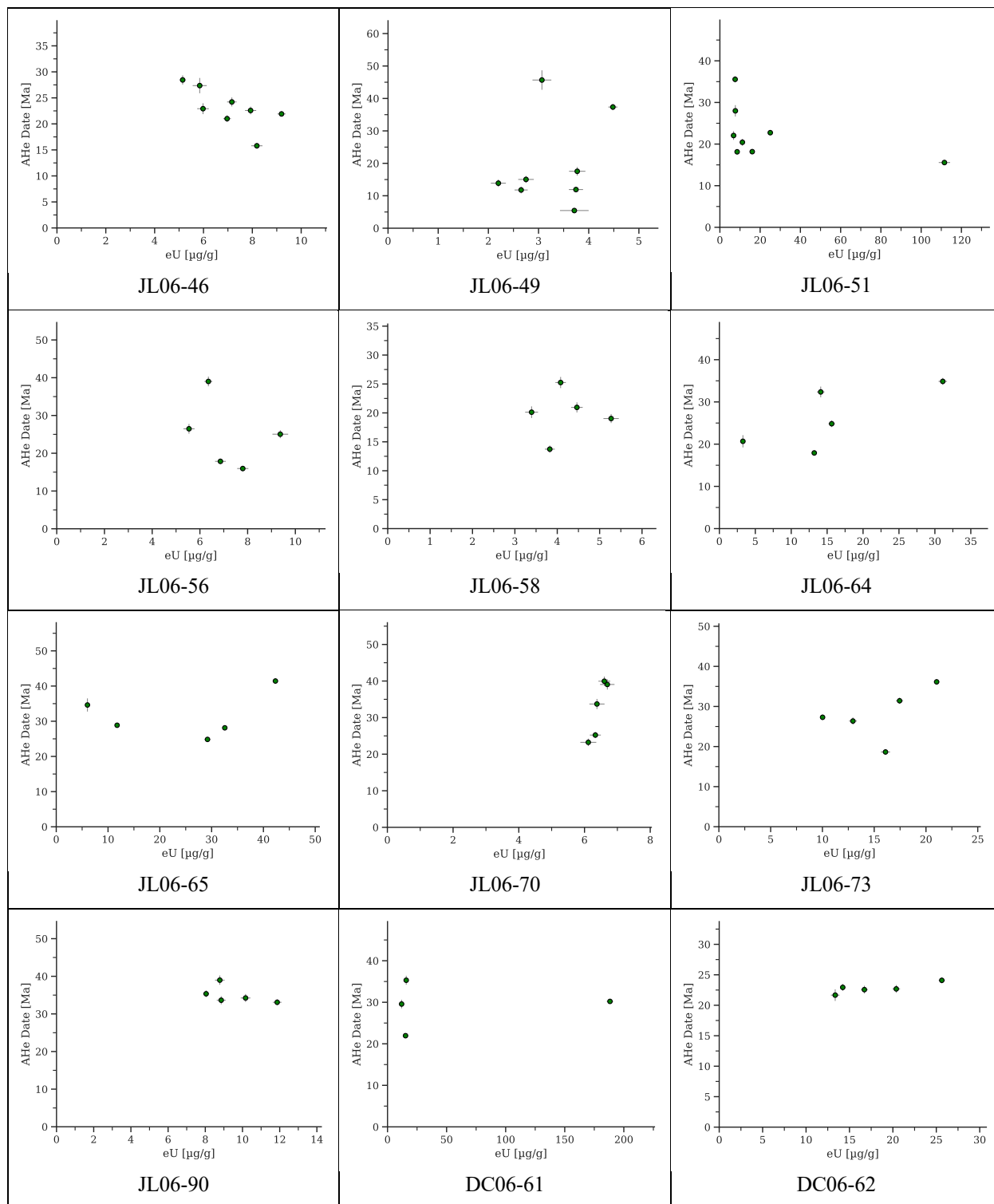


Figure A.2: eU vs date plots for single grain AHe data. eU – effective uranium concentration.



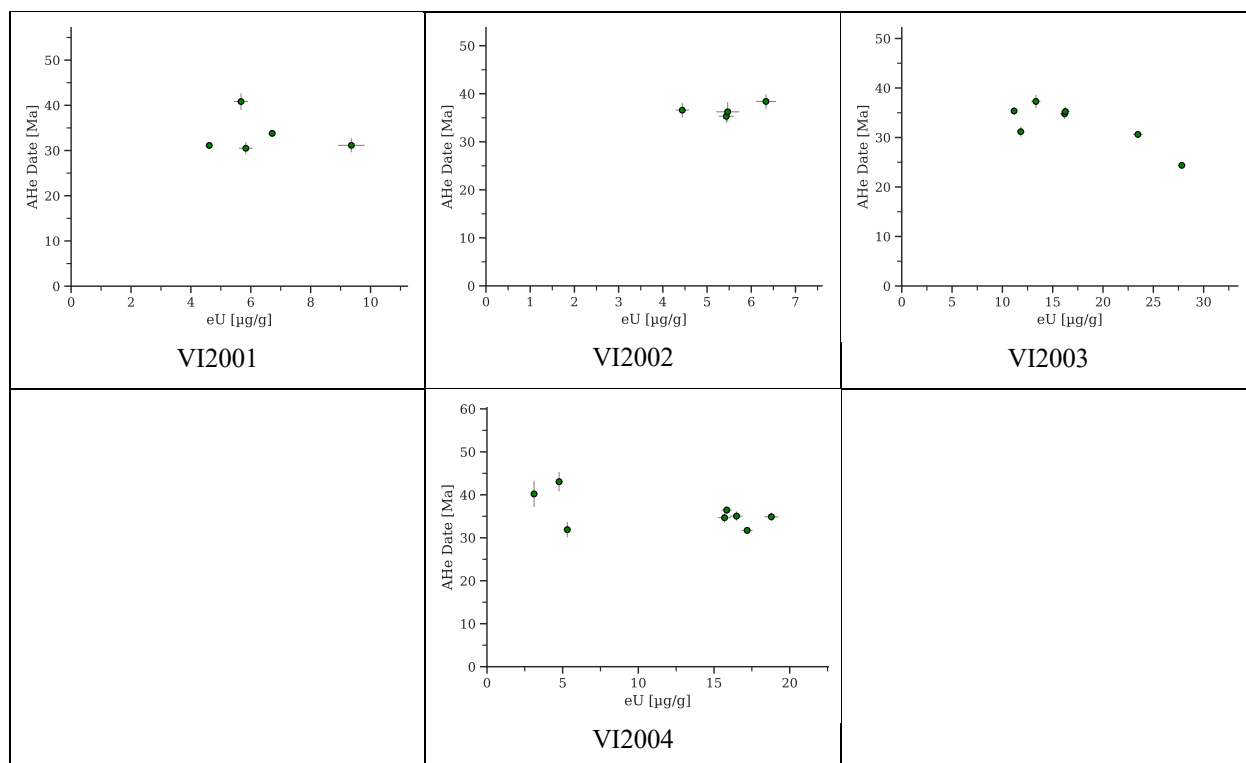
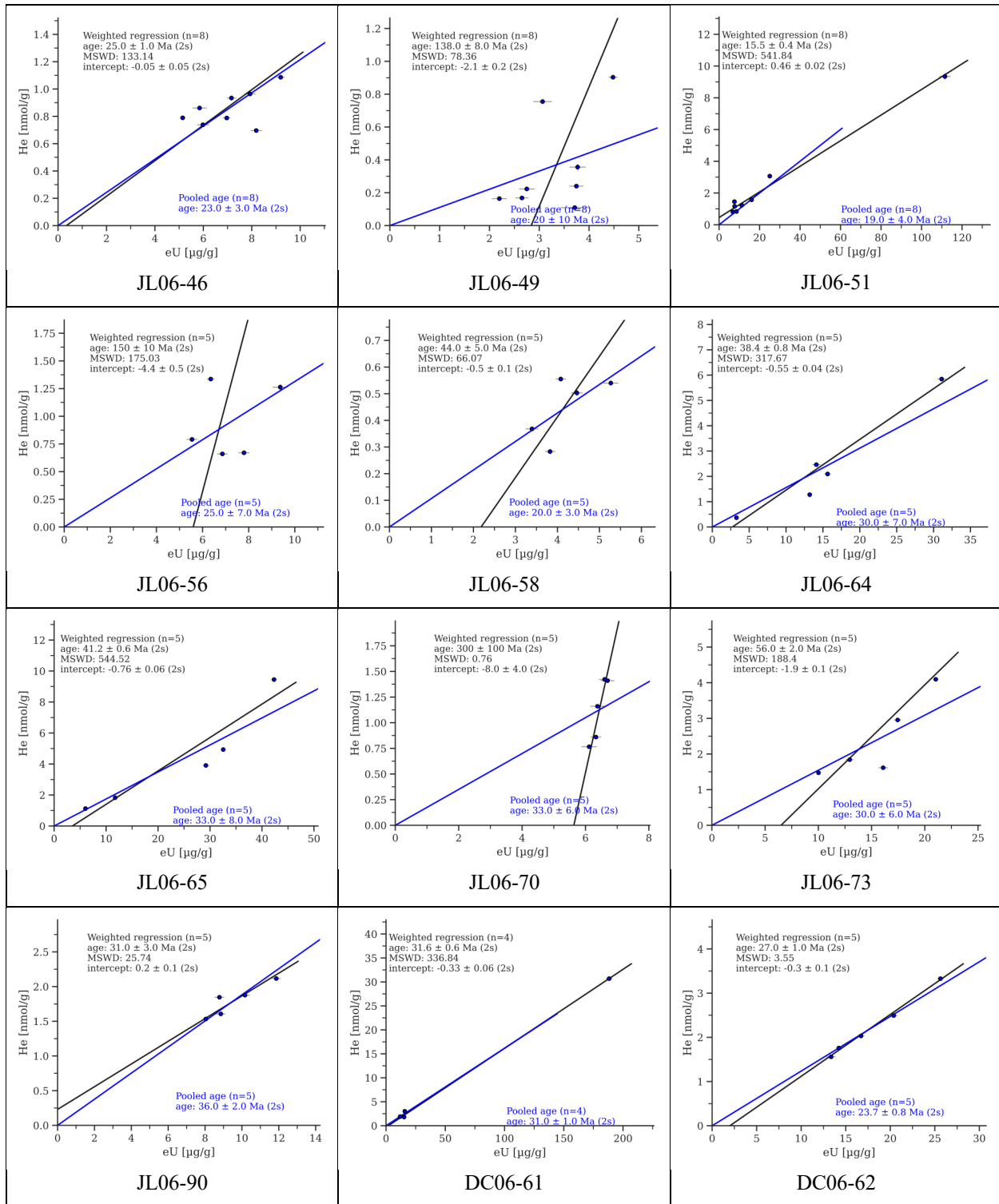


Figure A.3: eU vs [He] plots for single grain AHe data. eU – effective uranium concentration (parent), [He] – corrected He content (daughter).



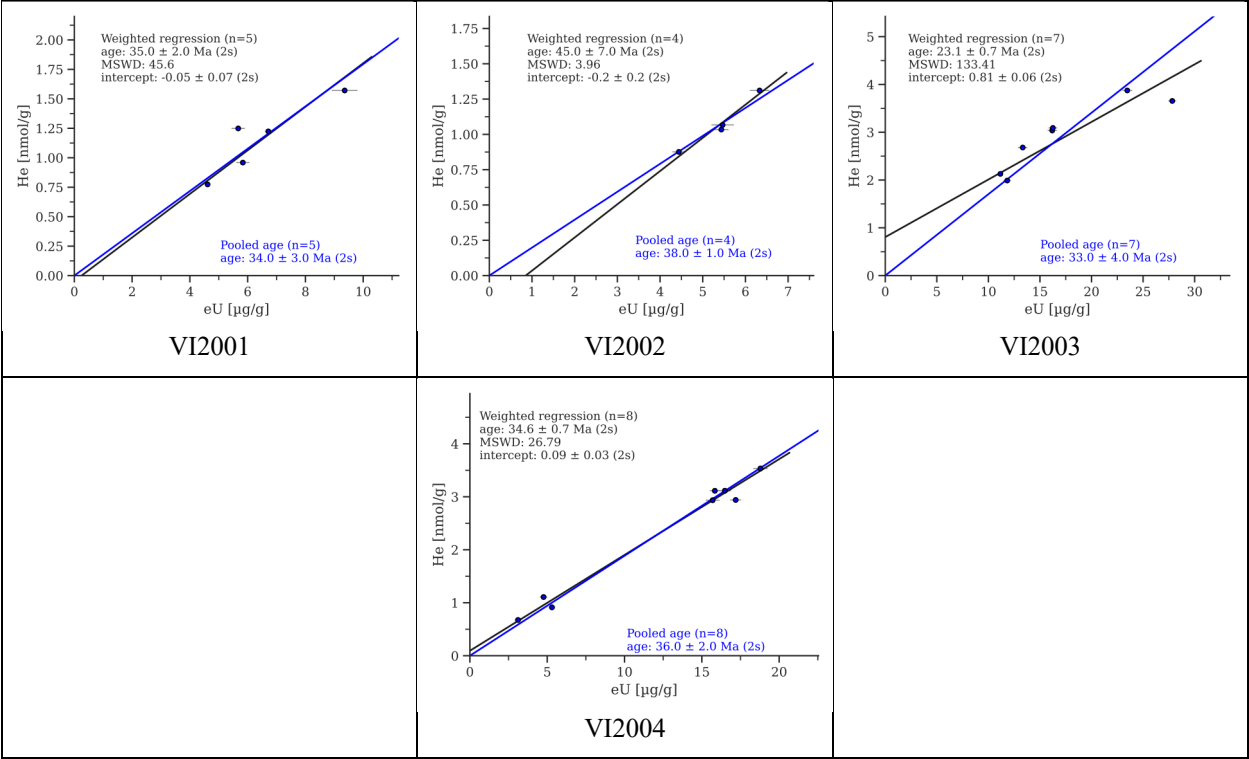
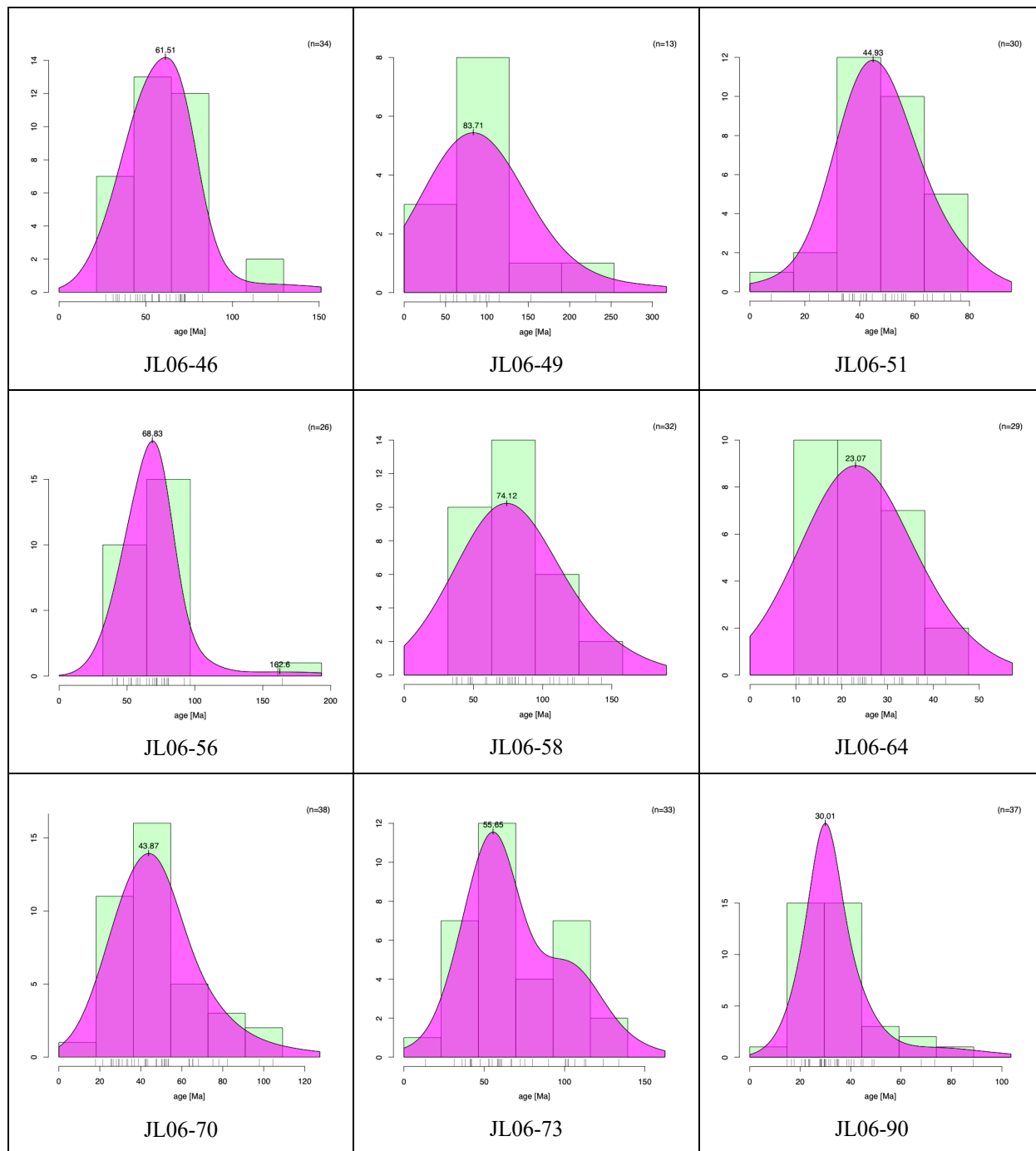


Figure A.4: Kernel Density Estimates (KDE plots) of single grain AFT dates.



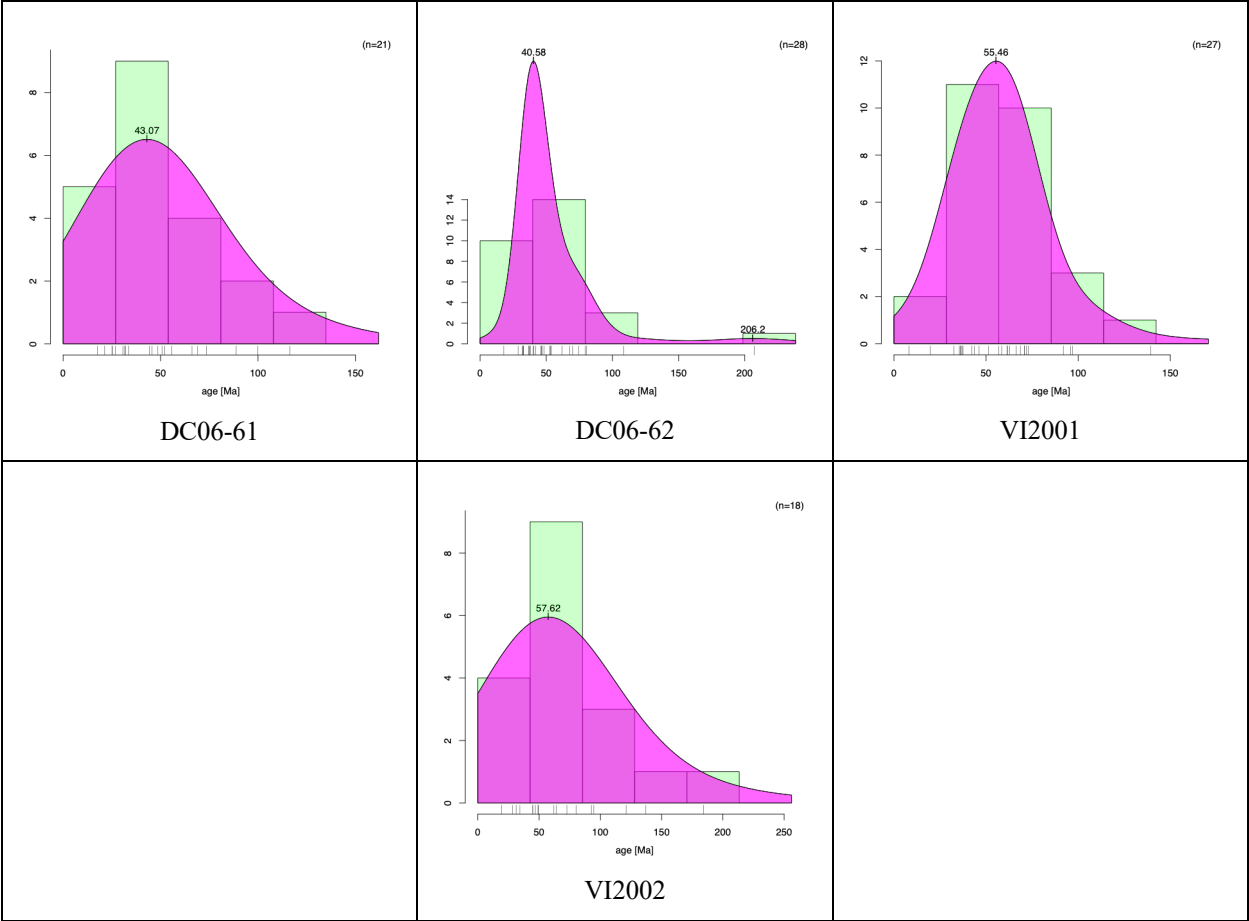
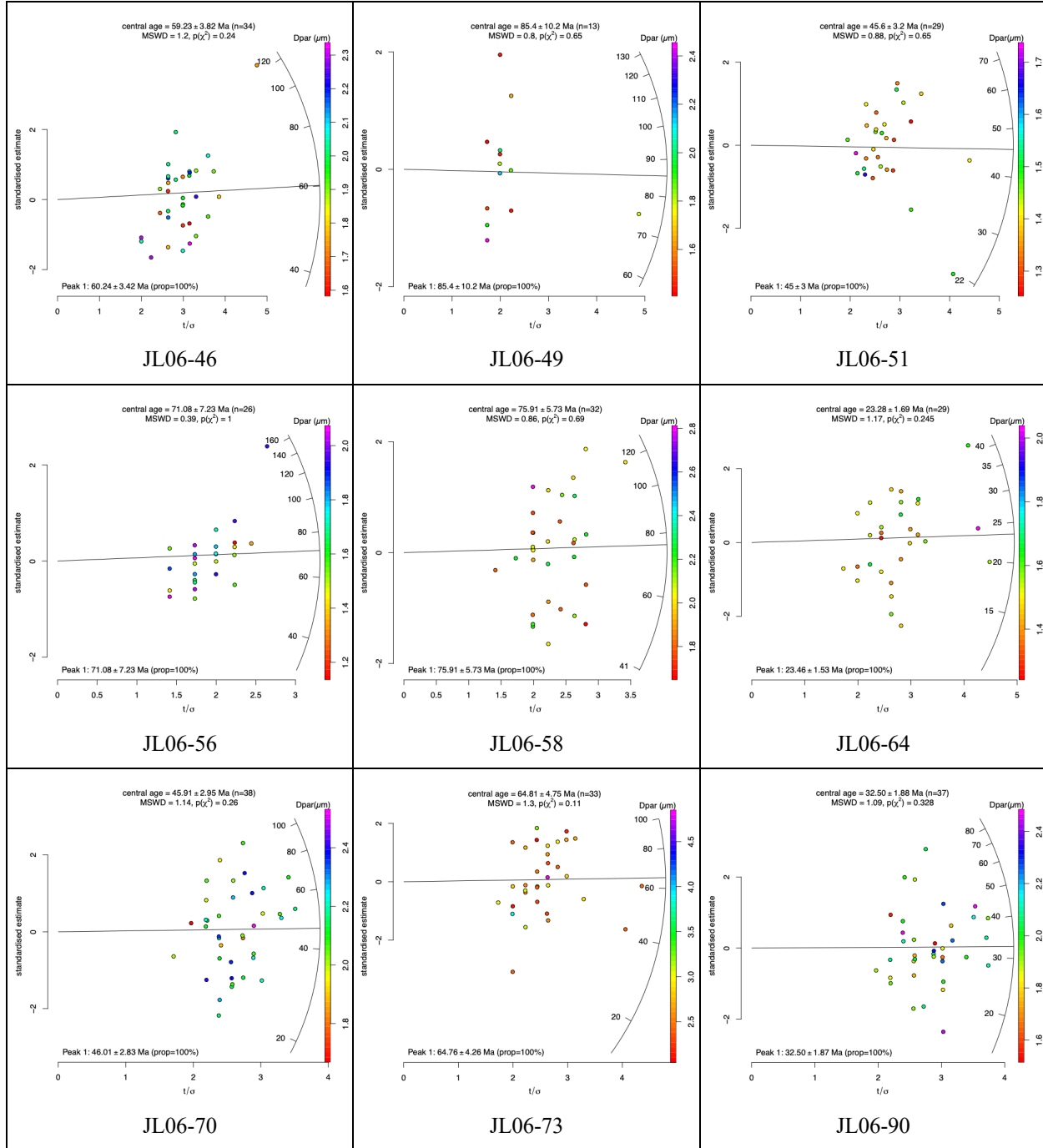


Figure A.5: Radial plots of single grain AFT results for individual samples. MSWD - mean squared weighted deviation. $p(\chi^2)$ – probability density function of chi-square value to evaluate the scatter of age population. D_{par} : diameter of the track opening parallel to c-axis. Mixture mode was set “auto” when plotting.



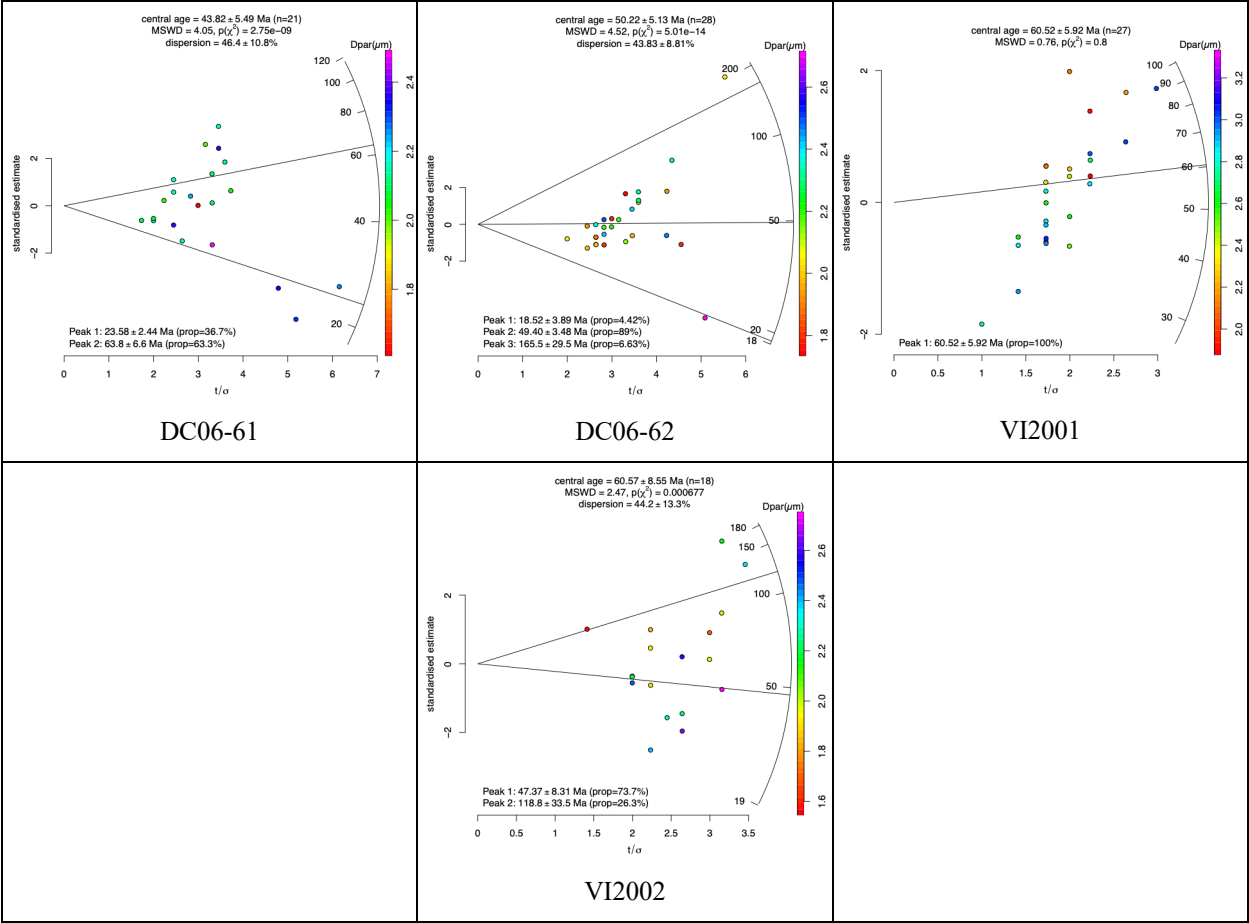
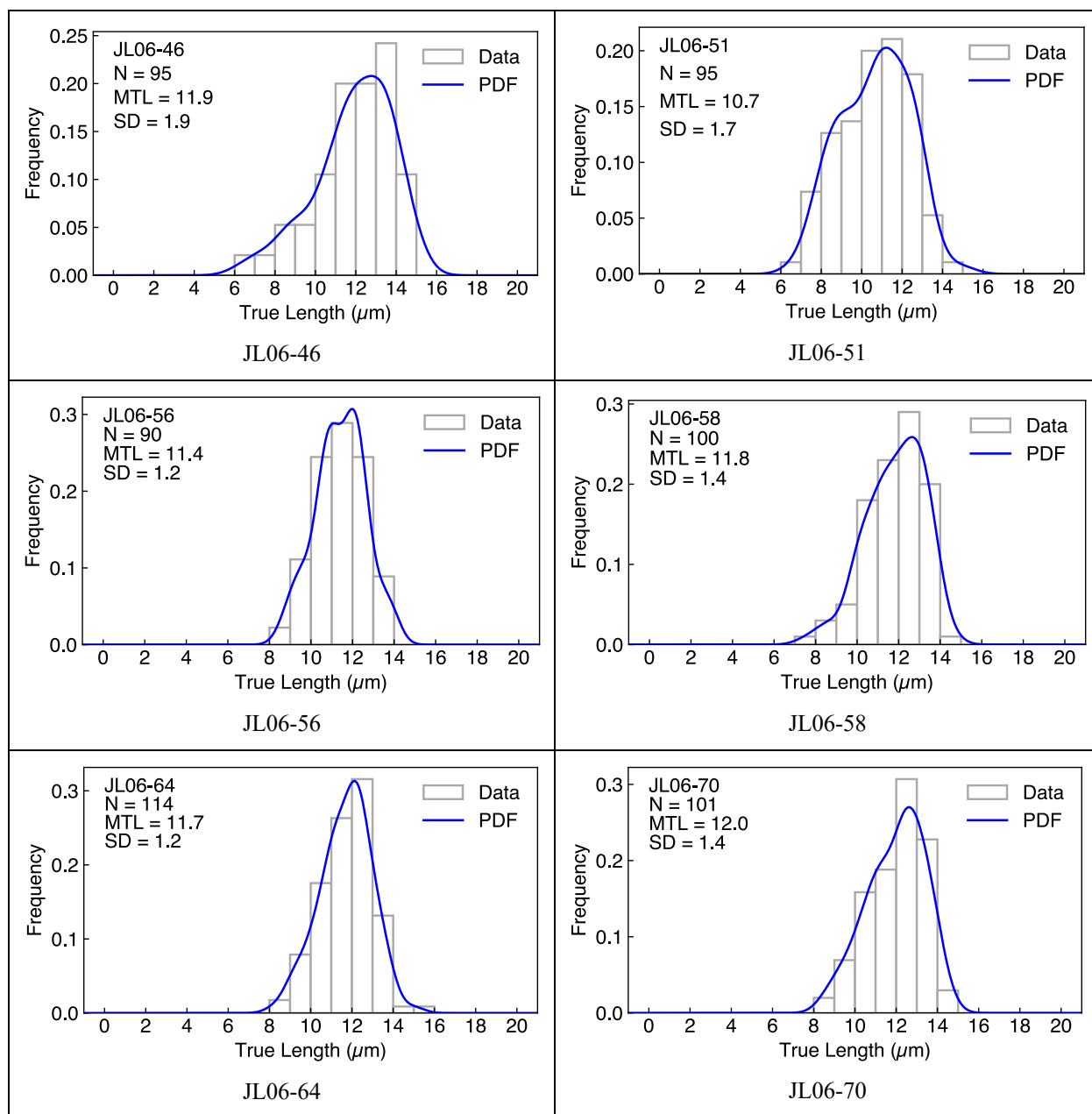


Figure A.6: Distribution histogram and probability density function (PDF) of confined track lengths for individual samples.



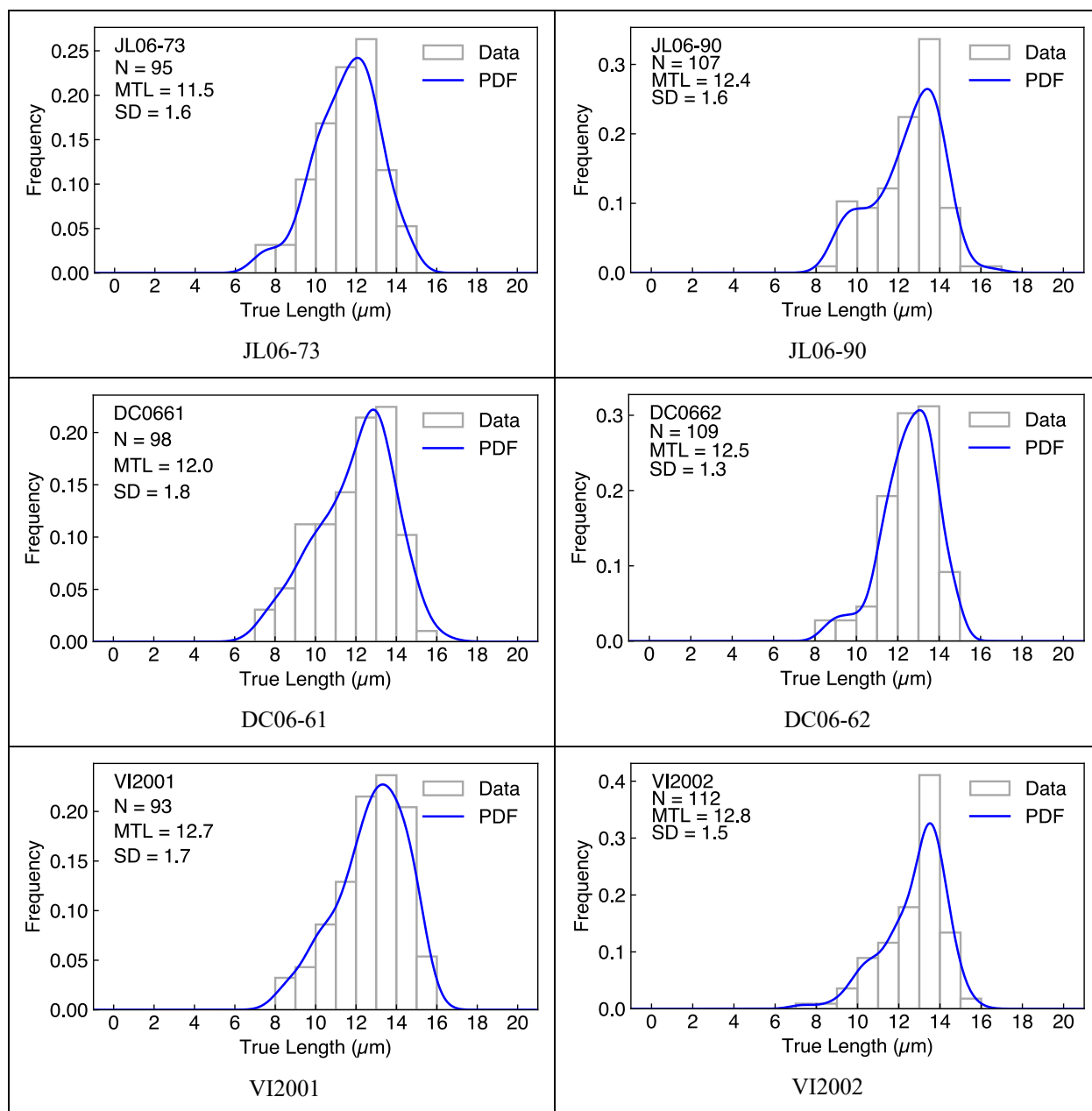
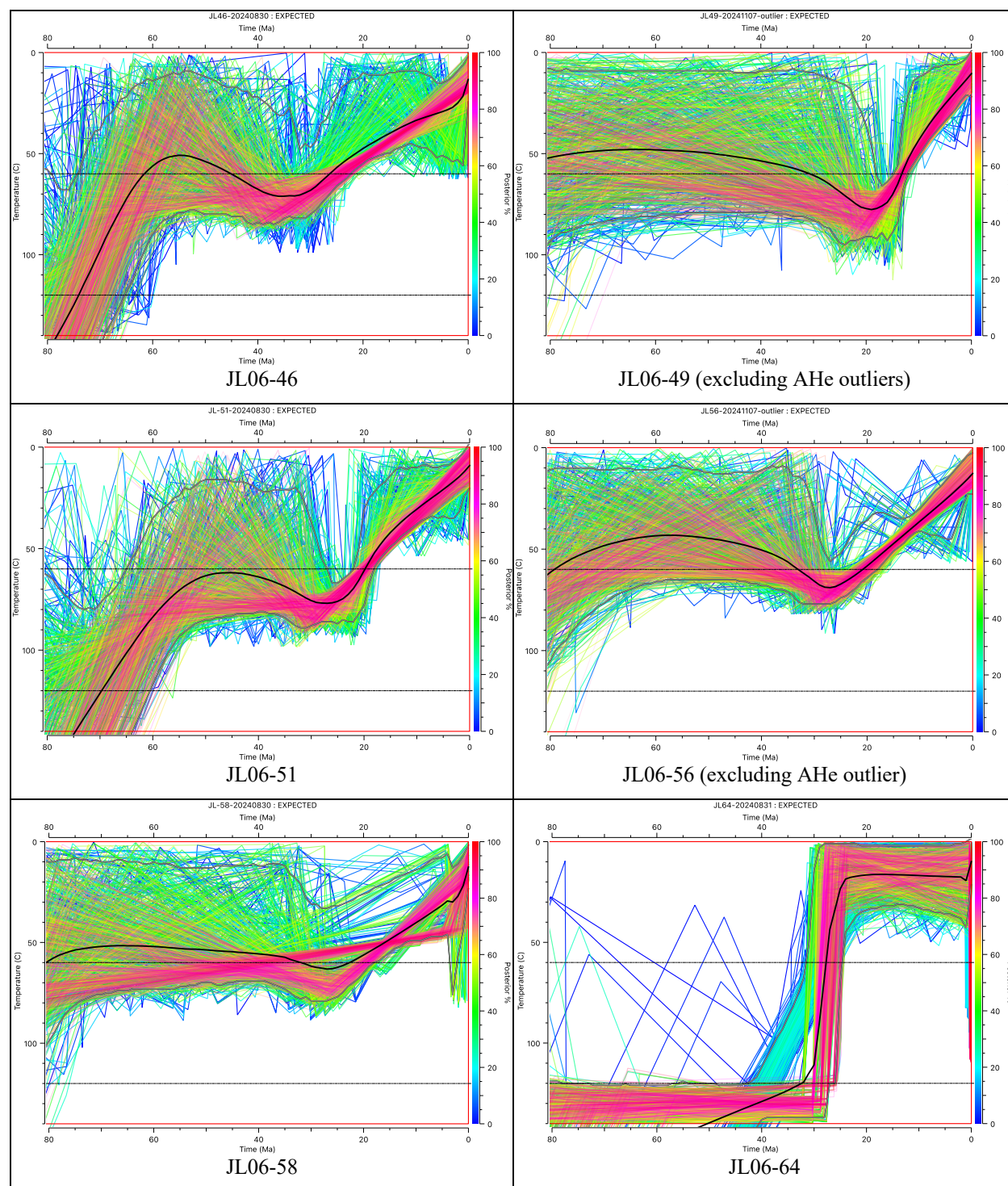
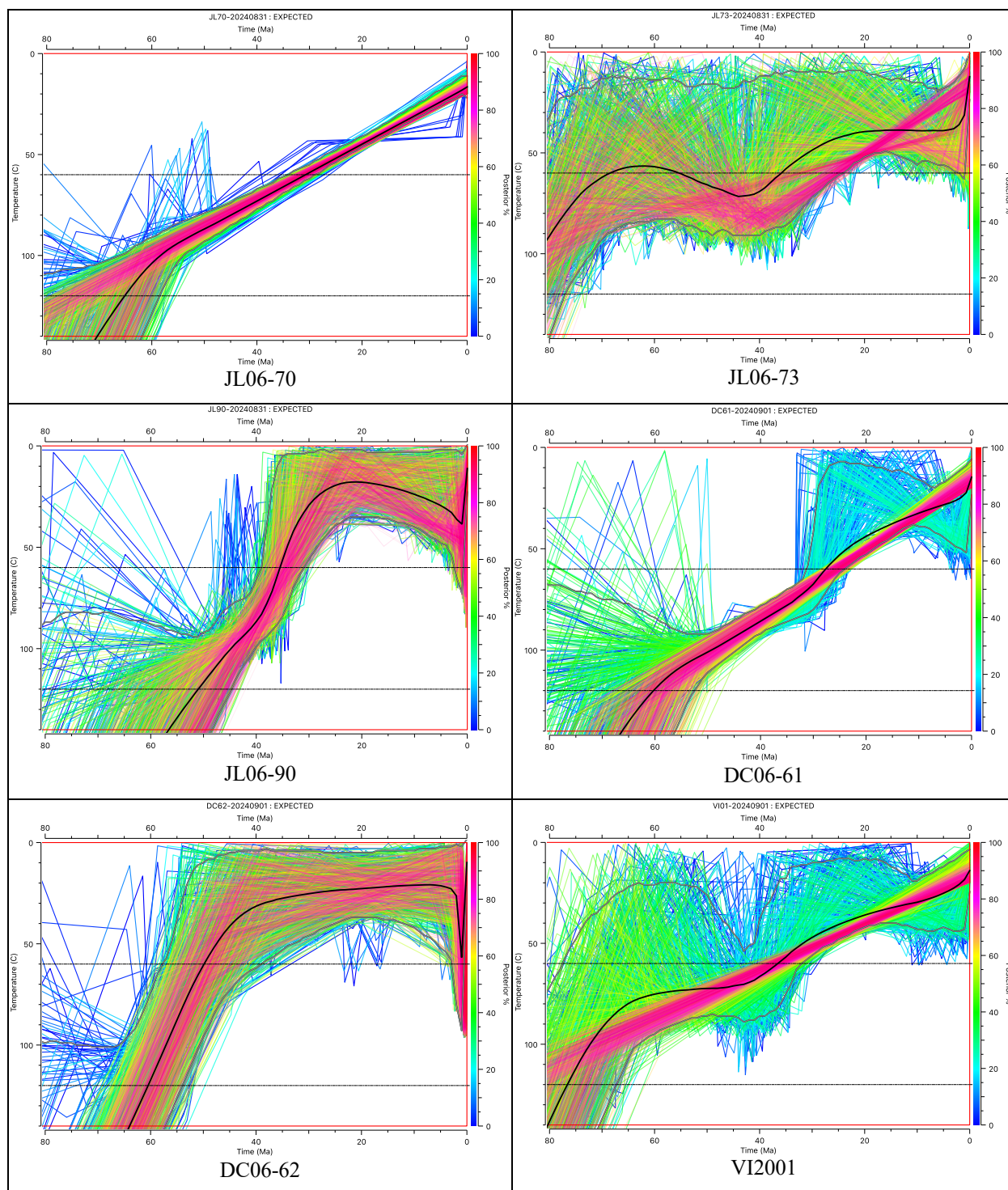
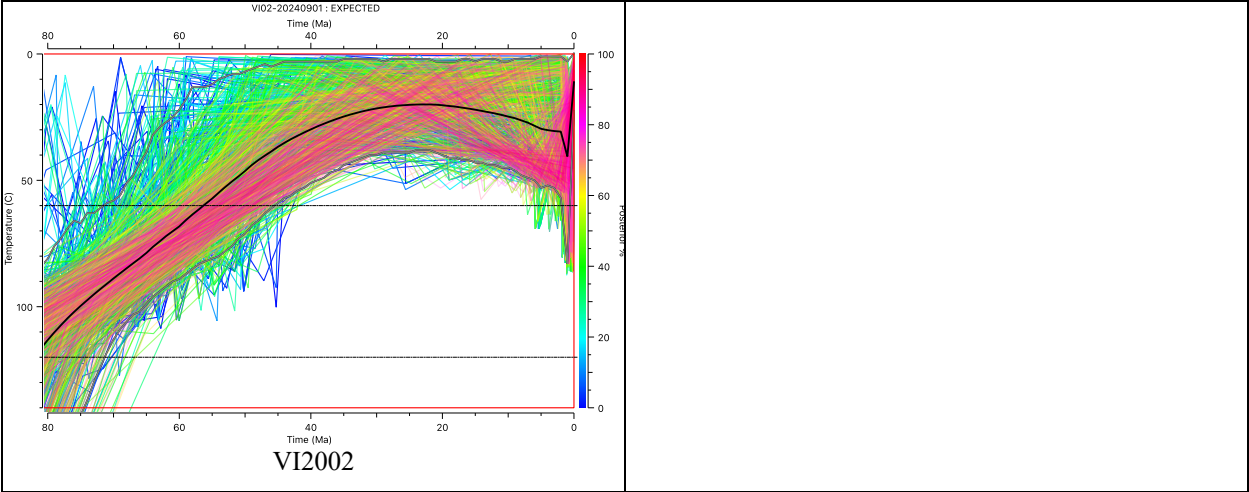


Figure A.7: Summary of QTQt outputs of time-temperature probability estimates for individual samples of Vancouver Island. These are original outputs with parameters allowing reheating and not sphere diffusion domain.







Appendix B

Chapter 3 Supplemental Material

B.1 Appendix B Tables

Table B.1: Single grain zircon (U-Th)/He data (ZHe).

<i>Note:</i>
a - Length is measured parallel to the c-axis and includes pyramidal terminations. It is measured twice on two perpendicular sides.
b - Width 1 is measured perpendicular to the c-axis. Width 2 is measured perpendicular to both the c-axis and width 1.
c - Geometry is defined as described in Figure 1 of Pupin (1980) and Figure 3 of Ketcham et al. (2011) in brackets. 1 is ellipsoid, 2 is cylinder, 3 is tetrahedral prism, and 4 is hexagonal prism
d - Np denotes the number of pyramidal terminations of the grain.
e - Blank-corrected ^4He
f - Uncertainties on ^4He , U, and Th are reported at 2σ standard deviations and include the propagated uncertainties on the measurements of the sample, blank, isotopic spike, and calibration standard.
g - Total blank-corrected ng of ^{238}U and ^{235}U . Total ^{238}U is measured and ^{235}U is calculated assuming $^{235}\text{U} = ^{238}\text{U}/137.818$ after Hiess et al. (2012).
h - Total blank-corrected ng of ^{232}Th
j - Rs is the radius of a sphere with an equivalent alpha-ejection correction as the grain, calculated using Ketcham et al. (2011).
k - Mass is the mass of the crystal. Determined from the measured grain dimensions, the volume assuming the reported grain geometry, and the volume equations and mineral densities in Ketcham et al. (2011).
l - Concentration of each element (He, U, and Th) computed from the absolute amount of the measured isotopes and the estimated dimensional mass. In some cases Sm may not be measured, for example in minerals like zircon with negligible Sm.
m - Uncertainties on U, Th, and He concentrations are reported at 2s and include the propagated total analytical uncertainties (TAU).
n - eU is effective uranium concentration. Calculated as $U + 0.238 \cdot \text{Th}$ after Appendix A of Cooperdock et al. (2019).
o - Uncertainty on eU is calculated as the quadratic sum of the uncertainties in U and Th concentrations weighted by their relative contributions
p - Uncorrected (U-Th)/He date is calculated iteratively using the first two terms of a Taylor expansion of the age equation (linear approximation)
q - Uncertainty on the uncorrected (U-Th)/He date is reported at 2s and includes the propagated total analytical uncertainties (TAU) on the U, Th, and He measurements.
r - Alpha-ejection correction for the crystal calculated using the proportion of U and Th contributing to ^4He production, and assuming homogeneous parent isotope distributions using Ketcham et al. (2011).
s - Corrected date calculated using the uncorrected date and the F_T correction factor
t - Uncertainty on the corrected (U-Th)/He date is reported at 2s and includes the propagated total analytical uncertainties (TAU) on the U, Th, and He measurements.

Field ID	Aliquot	Length 1 (μm) ^a	Width 1 (μm) ^b	Length 2 (μm) ^a	Width 2 (μm) ^b	Geometry ^c	Np ^d	⁴ He (fmol) ^e	$\pm$ fmol (2 σ , ABS) ^f	U (ng) ^g	$\pm$ ng (2 σ , ABS) ^f	Th (ng) ^h	$\pm$ ng (2 σ , ABS) ^f	Th/U
VI2208	160-01-1	460.9	148.6	462.3	149.0	3	1p1b	5666.9	7.5	7.04	0.28	3.24	0.19	0.46
	160-01-2	415.2	170.8	413.1	168.9	3	1p1b	4423.2	10.3	5.25	0.24	2.35	0.15	0.45
	160-01-3	433.1	178.2	436.7	133.1	3	1p1b	8125.8	14.0	11.29	0.53	4.56	0.27	0.40
VI2211	160-02-1	139.5	83.1	142.3	93.0	3	2p	515.9	1.1	0.88	0.04	0.41	0.03	0.47
	160-02-3	139.1	82.5	143.7	77.6	3	2p	321.5	1.1	0.49	0.02	0.24	0.02	0.48
VI2206	160-03-1	149.9	105.8	149.7	76.2	3	2p	1810.7	3.8	2.33	0.13	2.39	0.16	1.02
	160-03-2	167.2	119.2	166.5	94.6	3	2p	3989.3	8.6	5.32	0.40	5.76	0.40	1.08
	160-03-3	143.9	96.0	140.4	67.6	3	2p	423.5	1.3	0.61	0.03	0.37	0.04	0.62
DC0640	160-4-1	173.2	97.5	170.9	78.5	3	2	414.8	0.9	0.94	0.04	0.56	0.03	0.59
	160-4-2	172.4	89.8	170.9	78.7	3	2	440.9	0.6	1.39	0.04	0.69	0.03	0.50
	160-4-3	182.1	90.1	181.4	76.3	3	2	1103.3	1.6	2.26	0.07	2.74	0.14	1.21
DC0645	160-5-1	251.8	103.9	253.6	100.8	3	2	1125.0	2.2	2.41	0.08	0.73	0.04	0.30
	160-5-2	231.0	131.1	234.8	100.2	3	2	684.7	0.8	1.29	0.04	0.53	0.03	0.41
	160-5-3	254.9	109.1	255.8	101.2	3	2	959.9	1.7	2.03	0.05	0.63	0.03	0.31
DC0703	160-06-1	132.6	59.2	136.5	65.1	3	1b	70.9	0.2	0.51	0.02	0.27	0.02	0.53
	160-06-2	159.9	63.5	157.8	77.5	3	1p1b	68.6	0.3	0.48	0.02	0.25	0.02	0.53
	160-06-3	163.0	69.6	162.2	62.4	3	2b	89.3	0.2	0.60	0.04	0.29	0.02	0.49
CS1093	160-08-1	172.6	71.5	173.6	85.3	3	2p	315.0	1.0	1.98	0.13	0.84	0.05	0.42
	160-08-2	114.1	59.7	115.1	60.9	3	1p	230.3	0.7	1.57	0.11	0.59	0.05	0.38
	160-08-3	112.0	54.8	112.4	59.0	3	2p	85.1	0.2	0.60	0.03	0.21	0.01	0.35
AG044	160-12-1	175.8	107.8	178.3	98.8	3	2p	336.1	0.9	0.60	0.04	0.27	0.02	0.45
	160-12-2	182.3	84.6	186.0	80.6	3	1p	8.5	0.1	0.05	0.00	0.11	0.01	2.42
	160-12-3	123.7	68.3	120.8	65.4	3	2p	222.7	0.3	0.41	0.02	0.19	0.01	0.47
DC2201	160-14-1	123.7	76.6	118.8	68.9	3	2p	43.1	0.2	0.32	0.02	0.17	0.01	0.54
	160-14-2	129.3	83.2	127.8	79.0	3	2p	105.2	0.3	0.73	0.05	0.33	0.02	0.45
	160-14-3	118.0	68.6	117.9	64.9	3	2p	54.2	0.2	0.42	0.02	0.19	0.01	0.46
VI2200	160-15-1	158.9	64.5	160.0	64.9	3	2p	8.8	0.1	1.04	0.05	0.10	0.01	0.10
	160-15-2	157.8	81.3	156.1	69.0	3	2p	17.8	0.1	2.02	0.09	0.39	0.02	0.19
	160-15-3	145.2	69.1	145.5	69.3	3	2p	807.8	1.1	2.62	0.13	0.78	0.03	0.30
DC2201	160-14-1	123.7	76.6	118.8	68.9	3	2p	43.1	0.2	0.32	0.02	0.17	0.01	0.54
	160-14-2	129.3	83.2	127.8	79.0	3	2p	105.2	0.3	0.73	0.05	0.33	0.02	0.45
	160-14-3	118.0	68.6	117.9	64.9	3	2p	54.2	0.2	0.42	0.02	0.19	0.01	0.46
MW2020	160-17-1	180.0	102.8	182.7	79.2	3	2	310.9	0.8	1.01	0.03	0.37	0.02	0.37
	160-17-2	177.6	90.1	174.9	84.5	3	2	336.2	0.5	1.13	0.03	0.47	0.02	0.41
	160-17-3	135.5	98.5	135.8	68.4	3	2	133.3	0.2	0.71	0.02	0.31	0.02	0.44
	160-17-4	179.6	102.7	181.1	70.8	3	2	433.5	0.9	1.48	0.05	0.89	0.04	0.60
DC0661	160-18-1	137.2	67.4	138.0	69.8	3	2	182.5	0.5	0.53	0.02	0.23	0.01	0.42
	160-18-2	129.9	62.3	132.3	75.9	3	2	170.5	0.2	0.94	0.05	0.52	0.03	0.56
	160-18-3	140.8	65.5	142.9	77.5	3	2	169.3	0.5	0.66	0.03	0.31	0.02	0.47
	160-18-4	123.5	65.6		83.4	3	2	205.4	0.2	1.03	0.05	0.68	0.05	0.66
	160-18-5	244.3	89.3	254.3	107.1	3	2	257.8	0.8	0.74	0.03	0.34	0.01	0.47
JL06-51	160-19-1	156.4	59.2	155.4	70.3	3	2	161.5	0.5	0.58	0.02	0.17	0.01	0.29
	160-19-2	164.2	72.4	165.0	88.9	3	2	215.1	0.7	0.85	0.02	0.23	0.01	0.27
	160-19-3	148.4	84.0	147.9	64.2	3	2	89.2	0.3	0.34	0.01	0.14	0.01	0.43
AG114	160-20-1	138.0	58.3	139.5	74.3	3	2p	9.0	0.1	1.12	0.04	0.22	0.01	0.19
	160-20-2	108.0	60.4	113.6	76.2	3	no p	58.2	0.3	0.40	0.02	0.08	0.01	0.20
	160-20-3	144.5	99.7	141.9	84.4	3	1p	233.9	0.5	0.55	0.02	0.18	0.01	0.33
VI2001	160-21-1	224.6	96.2	226.1	78.1	3	2	122.1	0.3	0.54	0.02	0.25	0.01	0.47
	160-21-2	157.7	82.0	159.3	62.8	3	2	113.7	0.3	0.63	0.03	0.31	0.01	0.49
	160-21-3	175.3	109.3	173.4	102.2	3	2	319.4	0.8	0.97	0.04	0.54	0.02	0.55
	160-21-4	168.5	92.1		58.9	3	1	109.5	0.3	0.56	0.03	0.31	0.02	0.55
	160-21-5	197.1	90.8	197.7	114.8	3	2	414.6	1.0	0.99	0.06	0.52	0.03	0.53

Field ID	Rs (μm) ^j	Mass (μg) ^k	⁴ He (fmol/ μg) ^l	$\pm$ (2 σ , ABS) ^m	[U] (mg/kg) ^l	$\pm$ (2 σ , ABS) ^m	[Th] (mg/kg) ^l	$\pm$ (2 σ , ABS) ^m	eU (mg/kg) ⁿ	$\pm$ (2 σ , ABS) ^o	Uncorr Date (Ma) ^p	$\pm$ (2 σ , ABS) ^q	F _r ^r	Corr Date (Ma) ^s	$\pm$ (2 σ , ABS) ^t
VI2208	96.4	42.49	133.37	0.18	165.73	6.52	76.23	4.49	183.87	8.96	133.11	4.7	0.89	149.9	5.3
	105.6	48.13	91.90	0.21	109.11	4.90	48.85	3.18	120.74	6.64	139.59	5.6	0.90	155.1	6.2
	99.2	43.38	187.32	0.32	260.17	12.23	105.07	6.22	285.18	15.73	120.66	5.1	0.89	135.3	5.7
VI2211	47.4	3.01	171.40	0.37	293.82	11.96	136.74	9.86	326.36	17.56	96.70	3.5	0.76	127.2	4.6
	45.1	2.69	119.52	0.41	181.73	7.59	88.04	7.23	202.69	11.73	108.46	4.1	0.75	144.8	5.4
VI2206	49.4	3.44	526.38	1.12	678.53	36.73	694.26	45.72	843.77	53.12	114.79	5.1	0.77	149.9	6.6
	56.6	5.1	782.21	1.70	1043.09	78.26	1130.17	77.86	1312.07	107.87	109.75	6.6	0.79	138.4	8.3
	45.7	2.78	152.35	0.47	218.76	12.21	134.65	14.42	250.81	19.17	111.72	5.5	0.75	148.8	7.3
DC0640	50.5	4.01	103.44	0.22	233.69	9.06	139.03	7.18	266.78	12.33	71.56	2.4	0.77	92.5	3.1
	49.4	3.79	116.33	0.17	366.63	10.92	181.77	8.36	409.89	15.28	52.47	1.4	0.77	68.2	1.8
	49.7	4.02	274.44	0.40	561.86	17.66	681.82	33.83	724.14	28.73	70.01	1.8	0.77	90.8	2.4
DC0645	63.6	8.98	125.28	0.24	268.75	9.21	81.78	4.11	288.21	12.14	80.14	2.5	0.82	98.2	3.1
	66.7	9.44	72.54	0.09	136.94	4.32	56.59	3.02	150.41	6.15	88.85	2.5	0.83	107.4	3.0
	65.0	9.51	100.93	0.18	213.13	5.59	66.77	3.54	229.03	8.44	81.24	1.9	0.82	98.7	2.4
DC0703	38	2.46	28.81	0.10	206.56	7.29	110.36	7.01	232.82	10.93	22.94	0.7	0.73	31.3	1.0
	43.1	3.15	21.79	0.10	151.76	7.35	80.16	5.36	170.84	9.98	23.64	1.0	0.76	30.9	1.3
	41.2	3.3	27.07	0.07	180.43	10.87	87.78	5.61	201.33	13.65	24.92	1.3	0.77	32.4	1.7
CS1093	47.4	3.47	90.78	0.27	571.05	36.89	240.75	13.44	628.35	44.05	26.77	1.5	0.76	35.2	2.0
	35.4	1.61	143.07	0.41	977.13	66.26	369.32	32.79	1065.03	85.70	24.89	1.5	0.69	36.0	2.2
	33.2	1.12	76.01	0.18	532.39	30.81	186.63	11.87	576.81	37.88	24.42	1.3	0.67	36.6	1.9
AG044	57.3	5.43	61.90	0.17	111.04	7.55	49.45	3.84	122.81	9.56	92.83	5.6	0.80	116.0	7.0
	50.5	5.03	1.69	0.01	8.92	0.74	21.53	1.69	14.04	1.28	22.28	1.3	0.77	29.0	1.7
	38.1	1.65	134.94	0.18	245.38	14.37	114.56	6.95	272.65	17.89	91.17	4.7	0.71	129.0	6.6
DC2201	40.1	1.85	23.31	0.10	171.96	9.75	92.65	4.41	194.01	11.89	22.27	1.1	0.72	31.0	1.5
	43.4	2.3	45.75	0.15	319.01	20.18	144.61	9.07	353.43	24.83	23.99	1.3	0.74	32.5	1.8
	37.4	1.52	35.67	0.13	276.11	15.48	128.03	4.82	306.58	18.09	21.57	1.1	0.70	30.8	1.5
VI2200	40.2	2.27	3.88	0.04	457.46	22.67	45.28	2.97	468.24	27.61	1.54	0.1	0.72	2.1	0.1
	44.7	2.83	6.30	0.03	713.26	31.46	136.07	5.36	745.65	35.87	1.57	0.1	0.75	2.1	0.1
	41.2	2.21	365.54	0.51	1185.02	60.23	355.11	12.90	1269.54	68.33	53.21	2.4	0.73	73.1	3.4
DC2201	40.1	1.85	23.31	0.10	171.96	9.75	92.65	4.41	194.01	11.89	22.27	1.1	0.72	31.0	1.5
	43.4	2.3	45.75	0.15	319.01	20.18	144.61	9.07	353.43	24.83	23.99	1.3	0.74	32.5	1.8
	37.4	1.52	35.67	0.13	276.11	15.48	128.03	4.82	306.58	18.09	21.57	1.1	0.70	30.8	1.5
MW2020	52.3	4.54	68.49	0.17	222.29	6.14	81.69	4.22	241.73	9.04	52.37	1.3	0.78	67.0	1.7
	51.2	4.18	80.44	0.12	271.40	7.99	111.77	5.22	298.00	11.09	49.91	1.3	0.78	64.2	1.7
	43.5	2.46	54.19	0.08	288.53	9.47	126.89	7.39	318.73	13.84	31.49	0.9	0.74	42.6	1.2
	49.7	4.08	106.25	0.22	362.45	12.97	218.41	9.43	414.43	17.21	47.42	1.5	0.77	61.4	1.9
DC0661	40.2	2.01	90.80	0.24	265.78	8.67	112.16	5.94	292.47	12.17	57.37	1.7	0.72	79.7	2.3
	39.4	1.86	91.68	0.13	504.42	26.45	280.91	15.46	571.28	33.65	29.73	1.3	0.72	41.6	1.9
	41.5	2.22	76.25	0.24	295.91	12.70	140.27	6.94	329.30	16.21	42.84	1.6	0.73	58.8	2.2
	40.1	1.88	109.28	0.12	546.99	25.32	362.94	24.31	633.37	35.88	31.96	1.3	0.72	44.4	1.8
	60.8	8.11	31.79	0.10	90.75	3.70	42.30	1.80	100.81	4.61	58.27	2.1	0.81	71.8	2.6
JL06-51	39.7	2.18	74.07	0.24	265.03	9.38	77.56	3.68	283.49	11.99	48.31	1.6	0.72	67.4	2.2
	47.0	3.30	65.18	0.22	257.65	7.57	68.43	4.12	273.94	11.38	44.01	1.2	0.76	58.0	1.6
	42.6	2.46	36.25	0.11	136.77	3.76	58.90	2.75	150.79	5.39	44.47	1.1	0.74	60.4	1.5
AG114	38.8	1.89	4.77	0.04	592.03	22.65	114.19	4.70	619.21	26.75	1.43	0.05	0.71	2.0	0.07
	38.8	2.37	24.56	0.12	170.23	9.35	34.78	2.17	178.51	11.21	25.49	1.30	0.72	35.6	1.81
	50.5	4.39	53.27	0.11	124.46	5.22	40.78	2.07	134.17	6.53	73.25	2.78	0.81	90.8	3.44
VI2001	54.1	5.82	20.97	0.04	93.04	3.93	43.56	2.03	103.41	4.97	37.54	1.4	0.79	47.6	1.8
	42.8	2.62	43.41	0.12	240.23	10.80	118.38	5.17	268.41	13.35	29.96	1.2	0.74	40.7	1.6
	57.4	5.36	59.58	0.15	180.71	8.18	100.15	4.33	204.54	10.22	53.85	2.1	0.80	67.3	2.6
	44.1	3.60	30.40	0.08	156.42	9.50	85.38	4.28	176.74	11.57	31.86	1.7	0.77	41.4	2.2
	58.6	6.23	66.54	0.16	159.38	9.21	83.81	5.42	179.32	11.80	68.51	3.4	0.81	85.1	4.3

Table B.2: Summary of apatite fission track results (AFT) and track length data for individual samples.

SAMPLE: 160-01											
Count data:											
Grain ID	Ns *	A (μm ²)†	A (cm ²)	ρs (n/cm ²)§	238U content (ppm)	238U 2SE (ppm)#	Dpar (μm)**	Dpar SD (μm)††	Single-grain Age (Ma)	Age 2SE (Ma)	
Grain01	10	11344.78	1.13E-04	88146.26			5.13	0.33			
Grain02	9	16436.90	1.64E-04	54754.85			5.85	0.55			
Grain03	31	28099.08	2.81E-04	110323.90			5.42	0.39			
Grain04	20	13465.89	1.35E-04	148523.40			5.83	0.61			
Grain05	6	7097.20	7.10E-05	84540.38			5.04	0.77			
Grain06	7	12999.68	1.30E-04	53847.48	6.77	1.19	4.91	0.27	15.34	11.9	
Grain07	12	11113.33	1.11E-04	107978.41			5.42	0.76			
Grain08	6	5961.50	5.96E-05	100645.83			4.93	0.41			
Grain09	15	7854.49	7.85E-05	190973.55			5.31	0.42			
Grain10	8	7632.33	7.63E-05	104817.21			5.37	0.48			
Grain11	18	18042.03	1.80E-04	99767.05	3.56	0.30	6.80	0.77	53.89	25.82	
Grain12	10	17852.74	1.79E-04	56013.81	2.92	0.32	5.44	0.70	36.89	23.68	
Grain13	10	7848.48	7.85E-05	127413.28			5.04	0.44			
Grain14	16	14665.01	1.47E-04	109103.20			5.46	0.66			
Grain15	15	14339.35	1.43E-04	104607.27			5.26	0.49			
Grain16	6	5861.00	5.86E-05	102371.63			5.42	0.71			
Grain17	8	28802.56	2.88E-04	27775.31	2.75	0.26	5.61	0.22	19.51	13.92	
Grain18	19	13965.50	1.40E-04	136049.51	7.65	0.80	5.58	0.38	34.23	16.1	
Grain20	16	13970.38	1.40E-04	114527.99			5.23	0.72			
Grain21	17	10349.20	1.03E-04	164263.93			4.69	0.38			
Grain22	9	19574.00	1.96E-04	45979.36	2.38	0.22	5.35	0.10	37.16	25.02	
Grain23	23	21267.02	2.13E-04	108148.69	4.47	0.44	5.57	0.46	46.54	19.93	
Grain24	6	9247.87	9.25E-05	64879.84	7.22	0.75	4.97	0.43	17.34	14.27	
Grain25	9	12160.21	1.22E-04	74011.89			4.26	0.79			
Grain26	23	21542.47	2.15E-04	106765.85	3.30	0.29	6.36	0.96	62.09	26.46	
Grain27	4	10694.29	1.07E-04	37403.14	3.99	0.37	5.20	1.14	18.07	18.15	
Grain28	22	16004.94	1.60E-04	137457.52			5.23	0.26			
Grain29	12	14044.57	1.40E-04	85442.24	9.00	1.10	4.88	0.45	18.31	10.81	
Grain30	14	12290.73	1.23E-04	113906.95	3.74	1.32	5.16	0.43	58.54	37.52	
Grain31	16	16612.84	1.66E-04	96311.04	6.30	0.72	5.38	0.32	29.45	15.1	
Grain32	16	12836.82	1.28E-04	124641.42	6.11	0.68	5.25	0.69	39.27	20.12	
Grain33	8	12143.24	1.21E-04	65880.26	7.72	0.78	5.15	1.04	16.45	11.75	
Grain34	12	36407.91	3.64E-04	32959.87	2.68	0.38	4.73	0.18	23.73	14.1	
Grain35	16	20767.33	2.08E-04	77044.11	19.71	2.73	5.61	0.50	7.54	3.91	
Note:											
*Ns: number of spontaneous tracks											
†A: counting area											
§ρs: Spontaneous track density (tracks/cm2)											
#238U 2SE: 2 sigma standard error of 238U content											
**Dpar: fission track etch pit diameter parallel to c-axis											
††Dpar SD: Standard deviation of Dpar											

SAMPLE: 160-02										
Count data:										
Grain ID	Ns	A (μm^2)	A (cm^2)	ρs (n/cm^2)	^{238}U content	^{238}U 2SE (ppm)	Dpar (μm)	Dpar SD (μm)	Single-grain Age (Ma)	Age 2SE (Ma)
Grain01	3	6729.16	6.73E-05	44582.08			6.65	0.34		
Grain02	4	3447.45	3.45E-05	116027.64			5.98	0.44		
Grain03	6	9778.27	9.78E-05	61360.52			6.59	0.59		
Grain04	3	24150.66	2.42E-04	12422.02	2.95	0.40	6.08	0.49	8.12	9.44
Grain05	3	10074.70	1.01E-04	29777.56			5.66	0.20		
Grain06	3	9583.11	9.58E-05	31305.09			5.75	0.37		
Grain07	5	12145.50	1.21E-04	41167.49	1.94	0.16	5.83	0.67	40.78	36.64
Grain08	8	23690.88	2.37E-04	33768.26	1.92	0.18	6.39	0.48	33.8	24.11
Grain09	3	11020.45	1.10E-04	27222.11			6.00	0.69		
Grain10	3	11594.52	1.16E-04	25874.30	2.85	0.28	6.10	0.63	17.5	20.27
Grain11	6	10024.16	1.00E-04	59855.41			5.90	0.66		
Grain12	4	10701.31	1.07E-04	37378.60			5.62	0.34		
Grain13	5	12665.57	1.27E-04	39477.10			6.22	0.55		
Grain14	5	8551.76	8.55E-05	58467.51			5.53	0.45		
Grain15	4	16702.42	1.67E-04	23948.63			4.89	0.46		
Grain16	28	24671.55	2.47E-04	113491.03			6.45	0.22		
Grain17	2	6164.52	6.16E-05	32443.72			4.87	0.51		
Grain18	3	2698.43	2.70E-05	111175.84			5.66	0.83		
Grain19	2	9884.85	9.88E-05	20232.99			5.72	0.15		
Grain20	5	4872.90	4.87E-05	102608.34			6.15	0.40		
Grain21	2	5409.86	5.41E-05	36969.54			5.37	0.61		
Grain22	5	8756.39	8.76E-05	57101.17			5.41	0.74		
Length data:										
Length Name	Length Number	Fission Track type	Apparent Length (μm)	Angle to C-axis ($^\circ$)	Mean Dpar (μm)	Dpar SD/SE (μm)	Dip ($^\circ$)	Corrected Z Depth (μm)	True Length (μm)	
Length01	1	C	12.66	37.98	4.55	0.00	6.68	1.47	12.74	
Length02	1	T	20.75	87.98	4.25	0.00	5.43	1.96	20.84	
Length03	1	T	20.04	39.89	5.57	0.00	1.40	0.49	20.05	
Length05	1	T	20.32	84.29	5.76	0.00	4.15	1.47	20.38	
Length06	1	T	18.00	71.01	6.16	0.62	6.26	1.96	18.11	
Length07	1	T	17.69	63.20	4.70	0.00	3.18	0.98	17.71	
Length09	1	T	17.63	59.74	5.43	0.82	6.40	1.96	17.73	
Length10	1	T	18.96	4.19	5.89	0.86	0.00	0.00	18.96	

SAMPLE: 160-03										
Count data:										
Grain ID	Ns	A (μm^2)	A (cm^2)	ρs (n/cm^2)	238U content	238U 2SE (ppm)	Dpar (μm)	Dpar SD (μm)	Single-grain Age (Ma)	Age 2SE (Ma)
Grain01	6	11285.65	1.13E-04	53164.88	3.30	0.89	3.44	0.57	31.00	26.65
Grain02	18	28446.81	2.84E-04	63275.99	7.18	1.33	3.73	0.39	16.99	8.60
Grain03	1	4220.51	4.22E-05	23693.82			4.54	0.00		
Grain04	2	4481.63	4.48E-05	44626.60			3.37	0.54		
Grain05	3	1819.32	1.82E-05	164896.52			3.96	0.21		
Grain06	3	5447.55	5.45E-05	55070.66			3.18	0.19		
Grain07	3	2425.10	2.43E-05	123706.22			3.26	0.26		
Grain08	13	10649.15	1.06E-04	122075.52	3.85	0.38	3.68	0.28	60.98	34.36
Grain09	3	3000.56	3.00E-05	99981.49			3.42	0.28		
Grain10	3	2746.89	2.75E-05	109214.24			3.60	0.00		
Grain11	6	6055.38	6.06E-05	99085.39	2.95	0.53	3.44	0.43	64.44	53.87
Grain12	2	4550.49	4.55E-05	43951.30			3.95	0.33		
Grain13	4	2602.54	2.60E-05	153696.21			3.80	0.08		
Grain14	11	12997.55	1.30E-04	84631.34			3.96	0.63		
Grain15	0	0.00	0.00E+00	0.00			0.00	0.00		
Grain16	2	3105.73	3.11E-05	64397.18			3.57	0.28		
Grain17	9	11700.74	1.17E-04	76918.18			3.32	0.33		
Length data:										
Length Name	Length Number	Fission Track type	Apparent Length (μm)	Angle to C-axis ($^\circ$)	Mean Dpar (μm)	Dpar SD/SE (μm)	Dip ($^\circ$)	Corrected Z Depth (μm)	True Length (μm)	
Length01	1	C	18.21	62.46	3.74	0.00	7.74	2.45	18.38	
Length02	1	C	17.81	34.04	3.04	0.08	3.16	0.98	17.83	
Length03	1	C	17.70	47.50	3.04	0.08	4.77	1.47	17.77	
Length04	1	C	15.80	67.58	2.97	0.00	0.00	0.00	15.80	
Length05	1	C	13.86	50.62	3.04	0.08	0.00	0.00	13.86	

SAMPLE: 160-05											
Count data:											
Grain ID	Ns	A (μm^2)	A (cm^2)	ps (n/cm^2)	238U content	238U 2SE (ppm)	Dpar (μm)	Dpar SD (μm)	Single-grain Age (Ma)	Age 2SE (Ma)	
Grain09	22	2469.96	2.47E-05	890701.43	17.77	3.83	2.18	0.09	96.07	45.90	22.95
Grain15	8	936.59	9.37E-06	854159.12	21.07	4.69	2.38	0.11	77.81	57.68	28.84
Grain17	7	1565.77	1.57E-05	447064.31	9.42	2.08	2.11	0.22	91.00	71.66	35.83
Grain18	4	935.34	9.35E-06	427650.41	17.27	3.51	2.50	0.24	47.64	48.61	24.31
Grain19	11	2297.30	2.30E-05	478822.75	18.06	4.19	2.40	0.06	50.99	32.95	16.47
Grain21	14	2212.34	2.21E-05	632814.74	4.83	0.97	2.22	0.24	248.15	141.70	70.85
Grain22	5	1253.14	1.25E-05	398999.30	11.27	2.47	2.13	0.23	68.00	62.62	31.31
Grain23	5	988.82	9.89E-06	505652.82	12.56	2.99	2.34	0.13	77.27	71.52	35.76
Grain25	12	2085.93	2.09E-05	575283.23	10.10	2.32	2.46	0.06	109.06	67.76	33.88
Grain28	4	2150.17	2.15E-05	186031.49	6.44	1.46	1.89	0.35	55.54	56.95	28.47
Grain30	10	2075.98	2.08E-05	481699.48	7.95	1.70	2.56	0.04	115.95	77.41	38.71
Grain31	15	2357.51	2.36E-05	636265.06	12.78	2.77	2.38	0.27	95.43	53.44	26.72
Grain32	18	2585.34	2.59E-05	696232.06	11.00	2.51	2.41	0.27	121.07	63.41	31.70
Grain33	11	2697.44	2.70E-05	407794.25	12.41	2.62	2.49	0.27	63.14	40.34	20.17
Grain34	12	2863.91	2.86E-05	419006.89	6.81	1.41	2.25	0.16	117.73	72.21	36.10
Grain35	14	3132.69	3.13E-05	446900.65	5.92	1.21	2.23	0.14	144.15	82.49	41.24
Grain36	13	2220.68	2.22E-05	585405.70	12.97	2.84	2.24	0.20	86.57	51.63	25.81
Grain37	10	2750.47	2.75E-05	363573.57	10.50	2.14	2.45	0.18	66.52	44.20	22.10
Grain38	10	2084.75	2.08E-05	479674.21	13.30	3.07	2.22	0.06	69.27	46.64	23.32
Grain39	13	2900.68	2.90E-05	448171.12	6.36	1.48	2.32	0.19	134.65	81.00	40.50
Grain40	12	2124.74	2.12E-05	564774.78	7.21	1.59	2.22	0.18	149.51	92.40	46.20
Grain42	15	2385.38	2.39E-05	628830.34	12.20	2.65	2.27	0.26	98.77	55.33	27.67
Grain44	12	2668.01	2.67E-05	449774.11	16.10	3.51	2.33	0.32	53.72	33.15	16.58
Grain45	13	2322.47	2.32E-05	559749.96	22.89	4.87	2.55	0.07	47.05	27.95	13.98
Grain46	14	3462.85	3.46E-05	404291.29	7.82	1.61	2.18	0.09	99.07	56.74	28.37
Grain47	11	3059.25	3.06E-05	359565.03	9.78	1.94	2.31	0.29	70.60	44.82	22.41
Grain48	17	4124.43	4.12E-05	412178.22	5.26	0.75	2.18	0.08	149.56	75.62	37.81
Grain49	21	4402.45	4.40E-05	477007.59	21.15	4.54	2.41	0.16	43.40	21.11	10.56
Grain50	15	3647.92	3.65E-05	411192.91	6.32	1.06	2.27	0.10	124.42	67.56	33.78
Grain51	13	3850.45	3.85E-05	337622.49	6.76	1.47	2.42	0.13	95.73	57.03	28.52
Grain52	17	3246.07	3.25E-05	523710.97	8.44	1.97	2.26	0.13	118.72	63.91	31.95
Grain53	14	2228.08	2.23E-05	628344.28	10.58	2.12	2.29	0.36	113.67	64.89	32.44
Grain54	27	3909.68	3.91E-05	690593.58	7.83	1.74	2.26	0.17	168.10	74.71	37.36

Length data:									
Length Name	Length Number	Fission Track type	Apparent Length (µm)	Angle to C-axis (°)	Mean Dpar (µm)	Dpar SD/SE (µm)	Dip (°)	Corrected Z Depth (µm)	True Length (µm)
Length01	1	C	11.29	43.25	2.09	0.37	4.99	0.98	11.33
Length02	1	T	10.41	68.97	2.46	0.00	16.43	2.94	10.82
Length03	1	C	13.04	22.20	2.39	0.03	0.00	0.00	13.04
Length04	1	C	10.47	89.49	2.11	0.08	5.38	0.98	10.52
Length05	1	C	13.06	24.80	2.12	0.49	4.31	0.98	13.10
Length05	2	C	14.23	79.06	2.12	0.49	18.09	4.42	14.90
Length08	1	C	12.60	85.47	2.13	0.22	13.52	2.94	12.94
Length09	1	T	12.67	77.59	2.32	0.14	4.44	0.98	12.71
Length10	1	T	10.15	74.47	2.08	0.41	0.00	0.00	10.15
Length11	1	C	12.13	52.43	2.35	0.25	23.87	4.91	13.08
Length12	1	C	11.59	66.77	2.20	0.19	19.79	3.93	12.24
Length14	1	T	13.83	67.78	1.83	0.14	4.07	0.98	13.86
Length15	1	C	10.91	63.35	1.71	0.39	13.00	2.45	11.18
Length16	1	T	12.40	82.94	2.44	0.31	2.27	0.49	12.41
Length16	2	T	11.67	52.97	2.44	0.31	14.61	2.94	12.04
Length17	1	C	6.99	35.65	2.34	0.06	16.32	1.96	7.26
Length18	1	C	12.63	73.38	1.99	0.19	4.46	0.98	12.66
Length19	1	C	12.29	74.72	1.98	0.17	11.52	2.45	12.53
Length20	1	C	13.21	53.39	2.06	0.05	2.13	0.49	13.22
Length21	1	C	12.52	46.49	2.20	0.11	0.00	0.00	12.52
Length22	1	C	12.57	75.21	1.87	0.26	0.00	0.00	12.57
Length23	1	C	10.93	55.83	1.56	0.06	10.35	1.96	11.10
Length24	1	C	13.44	76.07	2.04	0.08	8.40	1.96	13.58
Length25	1	C	13.63	47.98	2.32	0.12	14.60	3.44	14.06
Length25	2	C	13.07	57.14	2.32	0.12	13.02	2.94	13.40
Length27	1	C	13.18	79.41	2.22	0.26	6.41	1.47	13.27
Length28	1	C	12.84	57.76	2.13	0.06	4.38	0.98	12.88
Length28	2	C	9.16	79.13	2.13	0.06	15.54	2.45	9.48
Length29	1	C	9.32	67.12	1.76	0.26	3.02	0.49	9.33
Length31	1	T	11.55	63.77	2.33	0.05	12.26	2.45	11.81
Length32	1	T	11.31	59.48	2.06	0.46	10.00	1.96	11.48
Length33	1	C	12.76	52.40	2.12	0.12	6.63	1.47	12.84
Length34	1	T	11.35	74.23	2.23	0.08	15.03	2.94	11.73
Length35	1	C	12.20	57.42	2.22	0.28	2.31	0.49	12.21
Length35	2	C	10.79	29.58	2.22	0.28	5.22	0.98	10.83
Length36	1	C	12.83	81.01	2.13	0.22	4.39	0.98	12.86
Length37	1	C	12.88	79.89	1.60	0.00	0.00	0.00	12.88
Length38	1	T	10.10	77.51	2.26	0.00	2.78	0.49	10.12
Length39	1	T	12.40	69.84	2.19	0.24	9.11	1.96	12.55
Length40	1	C	11.30	89.43	2.10	0.00	2.49	0.49	11.31
Length41	1	C	12.31	86.15	2.16	0.02	2.28	0.49	12.32
Length41	2	C	12.69	66.59	2.16	0.02	6.66	1.47	12.77
Length42	1	C	8.90	37.95	2.04	0.31	0.00	0.00	8.90
Length43	1	T	11.80	84.97	2.04	0.27	7.17	1.47	11.90
Length44	1	C	12.62	74.37	2.10	0.38	11.21	2.45	12.86
Length45	1	C	11.12	80.97	2.20	0.47	0.00	0.00	11.12
Length46	1	T	12.75	22.51	2.11	0.27	2.21	0.49	12.76
Length46	2	T	11.03	23.10	2.11	0.27	10.26	1.96	11.20
Length47	1	T	11.54	78.54	2.20	0.18	25.16	4.91	12.54
Length49	1	C	10.75	48.26	1.91	0.00	2.62	0.49	10.76
Length50	1	T	11.73	61.81	2.18	0.00	9.63	1.96	11.90
Length51	1	C	10.95	31.63	2.00	0.00	2.57	0.49	10.96
Length52	1	C	11.60	45.25	2.27	0.07	7.29	1.47	11.69
Length53	1	C	7.83	77.96	2.27	0.00	10.84	1.47	7.97
Length53	2	C	10.21	84.01	2.27	0.00	5.52	0.98	10.25
Length54	1	C	12.34	79.32	1.96	0.55	31.14	6.38	13.89
Length55	1	T	8.32	49.33	1.61	0.06	10.20	1.47	8.44
Length56	1	T	12.75	65.15	2.30	0.18	2.21	0.49	12.76
Length57	1	C	9.09	63.65	2.39	0.00	9.32	1.47	9.21
Length58	1	T	14.09	66.45	2.21	0.12	2.00	0.49	14.09
Length59	1	C	12.99	79.20	2.34	0.17	8.69	1.96	13.14
Length59	2	C	13.73	61.57	2.34	0.17	0.00	0.00	13.73
Length60	1	C	10.94	87.87	2.16	0.27	2.57	0.49	10.95
Length61	1	C	10.99	80.22	1.91	0.00	18.22	3.44	11.52
Length62	1	T	12.68	66.30	2.34	0.09	0.00	0.00	12.68
Length63	1	C	12.03	63.19	1.83	0.16	7.03	1.47	12.11
Length64	1	T	10.92	87.35	2.44	0.26	5.16	0.98	10.96
Length65	1	C	11.46	19.05	2.09	0.12	9.86	1.96	11.63
Length66	1	T	11.86	36.63	2.03	0.08	0.00	0.00	11.86
Length67	1	T	11.65	73.45	2.25	0.22	2.41	0.49	11.67
Length68	1	T	13.51	51.04	2.48	0.19	4.17	0.98	13.55
Length69	1	C	12.52	65.11	2.40	0.22	2.25	0.49	12.53
Length69	2	C	13.69	65.12	2.40	0.22	4.11	0.98	13.73
Length70	1	C	13.46	77.54	2.20	0.30	4.18	0.98	13.50
Length71	1	T	11.48	36.69	1.66	0.25	7.37	1.47	11.58
Length71	1	C	10.55	79.43	1.66	0.25	0.00	0.00	10.55
Length72	1	C	10.75	64.94	2.20	0.11	7.87	1.47	10.85
Length73	1	C	11.61	62.05	2.19	0.00	7.28	1.47	11.71
Length73	2	C	9.01	55.28	2.19	0.00	3.12	0.49	9.02
Length74	1	C	12.49	56.23	1.83	0.25	2.25	0.49	12.50
Length75	1	C	11.70	79.96	1.83	0.25	7.23	1.47	11.79
Length76	1	C	11.37	54.95	2.27	0.27	12.46	2.45	11.63
Length77	1	C	13.23	31.23	2.46	0.13	4.26	0.98	13.27
Length78	1	T	11.64	35.96	2.37	0.00	4.84	0.98	11.69
Length79	1	T	12.44	31.16	1.93	0.08	2.26	0.49	12.45
Length80	1	C	11.91	66.52	1.90	0.00	4.73	0.98	11.95
Length80	2	C	14.22	46.43	1.90	0.00	1.98	0.49	14.23
Length81	1	C	12.77	61.05	2.44	0.00	25.01	5.40	13.86
Length82	1	T	11.08	54.56	2.07	0.16	5.08	0.98	11.12
Length83	1	C	16.12	24.85	2.01	0.13	7.00	1.96	16.24
Length83	2	C	12.72	7.83	2.01	0.13	2.21	0.49	12.73
Length84	1	T	12.82	14.35	2.42	0.44	4.39	0.98	12.85
Length85	1	T	13.79	74.20	1.83	0.25	0.00	0.00	13.79
Length87	1	C	11.29	40.01	1.98	0.00	10.02	1.96	11.46
Length88	1	C	12.56	74.24	2.22	0.14	20.59	4.42	13.32
Length89	1	C	10.29	46.64	2.06	0.22	0.00	0.00	10.29
Length90	1	C	13.34	63.03	1.88	0.30	8.46	1.96	13.48
Length91	1	C	10.10	63.73	2.06	0.22	22.87	3.93	10.84
Length92	1	C	9.81	45.39	1.91	0.11	2.87	0.49	9.82
Length93	1	C	13.36	51.96	1.70	0.06	4.21	0.98	13.40
Length94	1	C	12.54	65.32	1.91	0.00	2.24	0.49	12.55
Length95	1	C	13.97	84.83	1.96	0.00	10.12	2.45	14.18

SAMPLE: 160-07										
Count data:										
Grain ID	Ns	A (um2)	A (cm2)	ps (n/cm-2)	238U content	238U 2SE (ppm)	Dpar (μm)	Dpar SD (μm)	Single-grain Age (Ma)	Age 2SE (Ma)
Grain01	2	5522.65	5.52E-05	36214.52	0.84	0.10	2.70	0.53	82.75	117.46
Grain02	2	4011.92	4.01E-05	49851.40	1.14	0.13	3.25	0.17	83.83	118.93
Grain03	3	2109.30	2.11E-05	142227.12			3.40	0.00		
Grain06	2	6237.29	6.24E-05	32065.19	0.82	0.08	3.70	0.21	75.29	106.75
Grain07	4	3525.92	3.53E-05	113445.43			3.28	0.59		
Grain08	6	3652.45	3.65E-05	164273.43	9.07	1.16	3.71	0.11	34.86	28.8
Grain09	2	3617.67	3.62E-05	55284.26	0.98	0.18	3.51	0.10	108.38	154.51
Grain11	4	2250.52	2.25E-05	177736.65			2.61	0.47		
Grain12	2	6059.31	6.06E-05	33007.09	3.10	0.43	3.53	0.42	20.50	29.12
Grain13	2	1820.97	1.82E-05	109831.56	1.02	0.16	3.10	0.12	205.12	291.88
Grain14	3	3972.12	3.97E-05	75526.47	0.71	0.11	3.62	0.43	202.31	235.59
Grain15	6	6275.49	6.28E-05	95610.12	6.24	0.93	3.22	0.26	29.52	24.51
Grain17	1	5004.64	5.00E-05	19981.45	1.31	0.26	4.71	0.00	29.42	59.12
Grain20	1	2803.09	2.80E-05	35674.95	0.96	0.13	2.45	1.09	71.09	142.51
Grain22	5	3748.92	3.75E-05	133371.60	0.97	0.09	3.67	0.19	260.85	234.47
Grain23	4	3317.65	3.32E-05	120567.35	0.81	0.08	3.33	0.47	281.09	282.54
Grain24	4	8318.95	8.32E-05	48082.98	2.64	0.47	3.73	0.00	35.11	35.67
Grain26	1	5991.89	5.99E-05	16689.22	0.85	0.10	4.15	0.02	37.68	75.49
Grain28	2	2771.81	2.77E-05	72155.06			3.50	0.34		
Grain29	7	4352.07	4.35E-05	160843.05			1.96	0.27		
Grain30	3	6280.31	6.28E-05	47768.38	1.06	0.11	3.42	0.20	86.06	99.78
Grain31	2	4620.01	4.62E-05	43289.98	0.82	0.12	3.13	0.39	101.54	144.32
Grain32	7	6164.95	6.16E-05	113545.04	0.89	0.13	3.61	0.18	242.61	186.95
Grain34	2	3420.22	3.42E-05	58475.72	1.00	0.16	3.84	0.46	112.17	159.58
Grain35	4	6773.81	6.77E-05	59050.93	1.02	0.14	3.49	0.37	111.03	112.11
Grain36	2	2796.16	2.80E-05	71526.62			2.71	0.16		
Grain37	2	2521.01	2.52E-05	79333.39	0.71	0.09	2.73	0.33	211.49	300.39
Grain38	3	4132.78	4.13E-05	72590.40	4.52	0.49	2.60	0.14	30.94	35.88
Grain39	3	3933.01	3.93E-05	76277.43	1.04	0.13	2.77	0.19	140.13	162.73
Grain40	3	5825.57	5.83E-05	51497.07	0.71	0.06	3.65	0.15	137.94	159.74
Grain41	5	6967.99	6.97E-05	71756.68	0.77	0.08	3.32	0.32	178.07	160.24
Grain42	2	3565.57	3.57E-05	56092.06	0.90	0.10	3.18	0.39	119.19	169.04
Grain43	0	0.00	0.00E+00	0.00			2.28	0.22		
Grain44	4	2105.73	2.11E-05	189958.01			3.06	0.31		
Grain45	4	2525.44	2.53E-05	158388.26			2.55	0.07		
Grain46	7	4514.26	4.51E-05	155064.24			3.31	0.27		
					1.73	1.99017086				
Length data:										
Length Name	Length Number	Fission Track type	Apparent Length (μm)	Angle to C-axis (°)	Mean Dpar (μm)	Dpar SD/SE (μm)	Dip (°)	Corrected Z Depth (μm)	True Length (μm)	
Length02	1	C	13.22	81.06	2.99	0.00	15.06	3.44	13.66	
Length03	1	C	14.81	59.04	4.16	0.00	3.80	0.98	14.84	
Length04	1	C	16.59	1.38	3.06	0.15	0.00	0.00	16.59	
Length05	1	C	15.73	60.96	2.96	0.13	1.79	0.49	15.74	
Length06	1	C	15.60	48.78	2.40	0.20	1.80	0.49	15.61	
Cf										
Length02	1	T	14.98	67.84	3.36	0.07	15.20	3.93	15.48	
Length03	1	T	15.17	55.47	3.36	0.31	0.00	0.00	15.17	
Length05	1	C	14.71	88.30	2.92	0.18	0.00	0.00	14.71	
Length06	1	T	15.01	61.24	3.50	0.12	1.87	0.49	15.02	
Length10	1	T	15.61	48.32	4.13	0.18	1.80	0.49	15.61	

SAMPLE: 160-08										
Count data:										
Grain ID	Ns	A (um2)	A (cm2)	ps (n/cm-2)	238U content	238U 2SE (ppm)	Dpar (μm)	Dpar SD (μm)	Single-grain Age (Ma)	Age 2SE (Ma)
Grain02	14	2709.52	2.71E-05	516695.99			2.74	0.22		
Grain03	6	1659.01	1.66E-05	361661.72			2.42	0.38		
Grain04	8	1335.76	1.34E-05	598910.25			2.49	0.14		
Grain05	20	4051.51	4.05E-05	493643.37	20.18	1.71	3.40	0.18	47.05	21.42
Grain06	11	8264.62	8.26E-05	133097.47	5.26	0.52	2.81	0.24	48.69	29.75
Grain07	14	2928.58	2.93E-05	478047.37	9.38	0.75	2.73	0.32	97.66	52.78
Grain08	9	3152.74	3.15E-05	285466.17	12.03	1.49	3.33	0.14	45.67	30.97
Grain09	5	3498.77	3.50E-05	142907.55			2.63	0.27		
Grain10	20	5953.31	5.95E-05	335947.38	11.82	1.66	2.52	0.28	54.66	25.62
Grain11	13	4450.06	4.45E-05	292130.60	14.12	1.17	2.39	0.33	39.81	22.33
Grain12	15	3258.61	3.26E-05	460319.59	17.95	1.72	2.87	0.48	49.32	25.9
Grain13	23	3113.63	3.11E-05	738688.52	48.87	3.63	3.11	0.20	29.12	12.34
Grain14	8	2055.24	2.06E-05	389248.18			2.87	0.05		
Grain15	12	3505.54	3.51E-05	342315.63	23.20	3.59	2.50	0.26	28.43	16.99
Grain16	12	2482.38	2.48E-05	483407.32			3.07	0.09		
Grain17	7	2865.78	2.87E-05	244261.83	9.31	1.22	2.91	0.07	50.46	38.71
Grain18	10	3735.06	3.74E-05	267733.47	12.73	1.32	2.68	0.19	40.5	25.96
Grain19	17	5449.08	5.45E-05	311979.49	11.05	1.58	2.92	0.21	54.3	27.46
Grain20	8	3804.14	3.80E-05	210297.18	12.04	2.28	2.82	0.11	33.65	24.63
Grain21	2	1763.35	1.76E-05	113420.55	12.35	1.93	2.46	0.37	17.71	25.2
Grain22	12	3488.32	3.49E-05	344004.92	13.66	1.61	2.85	0.19	48.45	28.55
Grain23	11	2734.64	2.73E-05	402246.36	12.23	1.20	3.19	0.10	63.19	38.6
Grain24	7	2019.11	2.02E-05	346687.80			2.55	0.13		
Grain25	14	2882.35	2.88E-05	485715.35	18.67	1.92	2.39	0.33	50.05	27.25
Grain26	11	2745.78	2.75E-05	400614.54			2.83	0.15		
Grain27	7	4056.19	4.06E-05	172575.84	3.21	0.25	2.90	0.03	102.84	78.14
Grain28	15	4491.78	4.49E-05	333943.05	10.74	1.24	2.78	0.09	59.76	31.62
Grain29	6	3307.99	3.31E-05	181378.95	14.80	1.56	2.77	0.45	23.62	19.45
Grain30	11	2971.72	2.97E-05	370155.87	17.19	1.77	2.67	0.07	41.45	25.36
Grain31	9	4382.18	4.38E-05	205377.09	13.80	2.26	2.29	0.19	28.67	19.68
Grain32	8	3844.38	3.84E-05	208095.90			2.93	0.17		
Grain33	7	4097.73	4.10E-05	170826.24	5.33	0.63	3.06	0.07	61.61	47.14
Grain34	15	3692.75	3.69E-05	406201.69	8.93	0.92	2.98	0.24	87.19	45.91
Grain35	13	3576.73	3.58E-05	363460.22	13.94	2.22	2.66	0.17	50.13	28.94
Grain36	12	3258.55	3.26E-05	368261.40	20.63	3.27	2.61	0.06	34.37	20.58
Grain37	13	6552.89	6.55E-05	198385.74	9.07	1.45	2.81	0.12	42.11	24.31
Grain38	22	7347.11	7.35E-05	299437.59	7.12	0.63	2.67	0.12	80.65	35.13
Grain39	8	3659.45	3.66E-05	218612.07	13.87	2.49	2.60	0.16	30.37	22.15
Grain40	13	2893.11	2.89E-05	449343.95	10.67	1.16	2.31	0.26	80.83	45.68
Grain41	8	3206.10	3.21E-05	249524.51	9.76	1.54	2.51	0.13	49.15	35.62
Grain42	16	4067.97	4.07E-05	393316.29	12.73	2.65	2.46	0.24	59.38	32.15

Length data:									
Length Name	Length Number	Fission Track type	Apparent Length (µm)	Angle to C-axis (°)	Mean Dpar (µm)	Dpar SD/SE (µm)	Dip (°)	Corrected Z Depth (µm)	True Length (µm)
Length01	1	C	11.52	55.30	2.58	0.27	9.81	1.96	11.68
Length02	1	C	10.24	44.04	2.38	0.37	5.50	0.98	10.29
Length03	1	C	14.07	42.35	2.48	0.13	8.02	1.96	14.21
Length03	2	C	12.79	64.15	2.48	0.13	8.83	1.96	12.94
Length04	1	T	11.89	65.24	2.43	0.10	14.34	2.94	12.25
Length05	1	T	13.93	36.60	2.91	0.17	4.04	0.98	13.97
Length06	1	T	10.58	87.12	2.07	0.19	0.00	0.00	10.58
Length06	1	C	10.02	32.93	2.07	0.19	2.81	0.49	10.03
Length08	1	C	17.22	52.47	2.86	0.49	3.27	0.98	17.25
Length09	1	T	15.32	52.82	2.77	0.23	1.84	0.49	15.33
Length10	1	T	14.53	60.37	2.81	0.08	11.69	2.94	14.83
Length11	1	C	14.14	57.17	2.86	0.10	14.06	3.44	14.55
Length12	1	C	14.31	40.21	2.71	0.04	1.97	0.49	14.32
Length13	1	C	13.73	74.35	2.82	0.19	4.10	0.98	13.77
Length14	1	C	13.62	52.60	2.91	0.60	4.13	0.98	13.66
Length15	1	T	10.90	31.19	2.85	0.22	5.17	0.98	10.94
Length16	1	C	10.01	87.22	3.01	0.43	8.45	1.47	10.12
Length17	1	C	13.81	84.09	2.36	0.00	4.08	0.98	13.84
Length18	1	T	12.21	75.20	2.30	0.11	9.25	1.96	12.37
Length19	1	C	11.76	6.23	2.45	0.00	4.79	0.98	11.80
Length19	2	C	11.11	9.38	2.45	0.00	7.62	1.47	11.21
Length20	1	C	12.85	57.81	2.35	0.47	11.01	2.45	13.08
Length21	1	T	10.64	48.42	2.39	0.27	2.64	0.49	10.65
Length22	1	T	8.79	59.12	2.41	0.14	6.42	0.98	8.84
Length23	1	C	13.50	79.10	1.87	0.45	2.08	0.49	13.51
Length23	2	C	9.86	29.18	1.87	0.45	0.00	0.00	9.86
Length24	1	T	11.95	82.31	2.76	0.21	0.00	0.00	11.95
Length24	1	C	11.54	77.62	2.76	0.21	12.27	2.45	11.80
Length24	2	C	13.50	63.33	2.76	0.21	12.60	2.94	13.82
Length25	1	C	12.86	66.23	2.71	0.39	13.23	2.94	13.20
Length26	1	C	12.95	48.70	2.46	0.16	4.35	0.98	12.98
Length27	1	C	12.96	70.88	2.62	0.00	6.53	1.47	13.04
Length27	2	C	13.32	56.36	2.62	0.00	12.77	2.94	13.64
Length28	1	C	13.07	45.06	2.74	0.00	6.47	1.47	13.15
Length29	1	C	10.80	52.12	2.72	0.32	2.60	0.49	10.81
Length30	1	C	12.13	85.07	2.25	0.39	2.32	0.49	12.14
Length31	1	T	10.91	25.68	2.67	0.13	2.58	0.49	10.92
Length32	1	C	13.15	52.56	2.25	0.18	4.28	0.98	13.19
Length33	1	C	13.49	67.05	2.23	0.18	8.37	1.96	13.64
Length34	1	C	11.87	56.36	3.21	0.23	0.00	0.00	11.87
Length35	1	C	14.30	40.28	2.10	0.23	9.88	2.45	14.51
Length36	1	C	14.43	41.53	2.54	0.12	3.90	0.98	14.46
Length37	1	C	14.02	62.42	2.24	0.14	0.00	0.00	14.02
Length37	2	C	12.38	71.73	2.24	0.14	4.55	0.98	12.42
Length38	1	C	14.09	75.68	2.40	0.05	2.00	0.49	14.09
Length39	1	C	13.77	52.39	2.65	0.00	14.45	3.44	14.19
Length40	1	T	12.55	64.91	2.23	0.22	2.24	0.49	12.56
Length41	1	C	15.90	61.32	1.85	0.00	7.09	1.96	16.02
Length42	1	C	11.24	50.02	2.90	0.14	0.00	0.00	11.24
Length43	1	C	13.76	32.79	2.85	0.19	6.14	1.47	13.84
Length43	2	C	14.15	21.73	2.85	0.19	1.99	0.49	14.16
Length44	1	T	13.80	60.17	2.84	0.19	0.00	0.00	13.80
Length45	1	C	12.09	69.73	2.59	0.37	7.00	1.47	12.18
Length46	1	T	14.41	87.32	2.45	0.24	1.95	0.49	14.42
Length47	1	T	9.95	16.71	2.66	0.15	2.83	0.49	9.96
Length47	1	C	11.56	59.20	2.66	0.15	4.87	0.98	11.60
Length47	2	C	10.35	69.79	2.66	0.15	5.44	0.98	10.40
Length47	3	C	8.58	56.71	2.66	0.15	0.00	0.00	8.58
Length48	1	C	13.77	46.50	2.13	0.26	6.14	1.47	13.85
Length48	2	C	13.12	81.05	2.13	0.26	8.61	1.96	13.26
Length49	1	C	11.59	80.89	2.62	0.06	2.43	0.49	11.60
Length50	1	C	14.49	17.45	2.54	0.23	0.00	0.00	14.49
Length51	1	C	9.96	32.17	2.56	0.09	0.00	0.00	9.96
Length51	2	C	10.32	83.15	2.56	0.09	8.20	1.47	10.42
Length52	1	C	11.44	66.81	2.49	0.44	9.88	1.96	11.61
Length53	1	C	14.22	29.76	2.49	0.02	0.00	0.00	14.22
Length53	2	C	13.55	15.97	2.49	0.02	8.33	1.96	13.69
Length53	3	C	14.45	58.34	2.49	0.02	1.95	0.49	14.45
Length54	1	C	7.77	67.44	2.08	0.14	0.00	0.00	7.77
Length54	2	C	13.55	48.49	2.08	0.14	0.00	0.00	13.55
Length55	1	T	12.43	33.05	2.09	0.02	6.80	1.47	12.52
Length55	2	T	11.07	26.32	2.09	0.02	7.64	1.47	11.17
Length56	1	C	13.30	56.29	2.25	0.00	10.63	2.45	13.53
Length57	1	C	13.20	69.20	2.46	0.21	10.71	2.45	13.43
Length58	1	C	14.14	46.75	2.53	0.24	5.98	1.47	14.22
Length59	1	C	13.64	77.52	2.69	0.18	6.20	1.47	13.72
Length59	2	C	12.78	80.79	2.69	0.18	6.62	1.47	12.86
Length60	1	C	14.46	33.51	2.90	0.00	3.89	0.98	14.50
Length61	1	C	16.56	78.71	2.59	0.16	13.72	3.93	17.02
Length62	1	T	14.84	89.64	2.53	0.06	11.45	2.94	15.12
Length63	1	C	15.59	76.20	2.09	0.48	0.00	0.00	15.59
Length63	2	C	13.65	89.95	2.09	0.48	4.12	0.98	13.68
Length64	1	T	15.48	40.26	1.86	0.06	1.82	0.49	15.49
Length65	1	C	14.46	27.40	2.39	0.06	7.80	1.96	14.59
Length66	1	C	14.21	77.05	1.90	0.13	16.04	3.93	14.74
Length67	1	C	13.16	69.71	2.21	0.32	4.28	0.98	13.19
Length68	1	C	14.13	43.85	2.44	0.02	0.00	0.00	14.13
Length68	2	C	11.48	76.16	2.44	0.02	7.37	1.47	11.58
Length68	3	C	10.10	55.87	2.44	0.02	8.39	1.47	10.20
Length69	1	T	12.75	75.70	2.18	0.21	2.21	0.49	12.75
Length70	1	C	13.22	74.63	2.22	0.18	15.06	3.44	13.66
Length73	1	T	14.26	59.88	2.43	0.05	1.97	0.49	14.27
Length74	1	C	15.28	45.92	2.36	0.26	3.68	0.98	15.31
Length75	1	C	14.71	88.52	2.61	0.02	7.67	1.96	14.84
Length75	2	C	12.36	79.29	2.61	0.02	0.00	0.00	12.36
Length76	1	C	12.89	67.29	1.98	0.13	0.00	0.00	12.89
Length77	1	C	14.74	26.94	1.94	0.19	1.91	0.49	14.75
Length78	1	C	13.19	62.47	2.52	0.15	10.72	2.45	13.42
Length78	2	C	11.94	53.10	2.52	0.15	11.86	2.45	12.19
Length80	1	C	12.74	64.97	2.17	0.23	8.87	1.96	12.89
Length81	1	C	14.07	55.67	2.30	0.06	2.00	0.49	14.08
Length82	1	T	15.10	68.84	2.43	0.00	5.60	1.47	15.17

SAMPLE: 160-09										
Count data:										
Grain ID	Ns	A (μm^2)	A (cm^2)	ρs (n/cm^2)	238U content	238U 2SE (ppm)	Dpar (μm)	Dpar SD (μm)	Single-grain Age (Ma)	Age 2SE (Ma)
Grain01	2	3038.53	3.04E-05	65821.39			3.78	0.00		
Grain02	6	4507.74	4.51E-05	133104.26	3.11	0.24	3.54	0.12	82.03	67.28
Grain03	4	3483.09	3.48E-05	114840.44			3.24	0.64		
Grain04	4	3013.95	3.01E-05	132716.24			3.22	0.45		
Grain05	4	2374.44	2.37E-05	168460.66	3.00	0.35	3.02	0.07	107.55	108.28
Grain06	5	2944.37	2.94E-05	169815.40			3.12	0.17		
Grain07	3	3536.90	3.54E-05	84820.12			2.95	0.23		
Grain08	2	4878.17	4.88E-05	40998.97	3.71	0.76	2.83	0.10	21.31	30.46
Grain09	4	4088.18	4.09E-05	97843.00	3.09	0.51	3.06	0.38	60.81	61.62
Grain10	4	3646.48	3.65E-05	109694.73	3.02	0.49	2.94	0.19	69.85	70.77
Grain11	5	5142.35	5.14E-05	97231.74	2.98	0.36	2.78	0.48	62.75	56.64
Grain12	3	3310.05	3.31E-05	90633.17			2.97	0.14		
Grain13	7	3946.80	3.95E-05	177358.72	4.21	0.86	2.95	0.10	80.89	63.34
Grain14	4	6703.52	6.70E-05	59670.15	2.64	0.37	2.19	0.29	43.44	43.87
Grain15	4	3464.58	3.46E-05	115454.11	2.90	0.55	2.56	0.19	76.31	77.68
Grain16	4	5839.69	5.84E-05	68496.74	2.94	0.34	2.59	0.40	44.83	45.12
Grain17	4	4557.38	4.56E-05	87769.65	2.72	0.38	2.95	0.21	61.91	62.5
Grain18	2	6947.80	6.95E-05	28786.10	2.89	0.31	2.83	0.17	19.2	27.23
Grain19	3	2949.35	2.95E-05	101717.28			2.92	0.11		
Grain20	4	4979.50	4.98E-05	80329.42	2.75	0.35	2.94	0.14	56.24	56.68
Grain21	5	3985.07	3.99E-05	125468.20	2.31	0.25	2.96	0.12	103.96	93.65
Grain22	2	2876.84	2.88E-05	69520.69			3.33	0.26	39.85	56.67
Grain23	2	3350.80	3.35E-05	59687.17	2.88	0.44	2.68	0.59		
Grain24	4	1851.36	1.85E-05	216057.27			3.24	0.10		
Grain25	3	4844.86	4.84E-05	61921.30	3.69	0.80	2.72	0.38	32.34	37.99
Grain26	3	2563.72	2.56E-05	117017.24	3.41	0.78	2.73	0.10	66.01	77.72
Grain27	4	3295.72	3.30E-05	121369.67	3.72	0.77	2.97	0.18	62.69	64.03
Grain28	3	4159.87	4.16E-05	72117.70	3.97	0.75	2.70	0.44	34.97	40.92
Grain29	2	3971.02	3.97E-05	50364.94	4.31	0.95	2.72	0.15	22.53	32.24
Grain30	4	3913.13	3.91E-05	102220.00	3.18	0.55	2.48	0.34	61.85	62.76
Grain31	4	6424.22	6.42E-05	62264.36	3.26	0.68	2.66	0.19	36.78	37.56
Grain32	3	4301.87	4.30E-05	69737.08	2.60	0.43	2.65	0.19	51.57	60.15
Grain33	5	3183.99	3.18E-05	157035.89	3.22	0.40	2.82	0.18	93.35	84.28
Grain34	3	3362.07	3.36E-05	89230.71	2.92	0.28	2.80	0.43	58.75	68.07
Grain35	4	3028.82	3.03E-05	132064.84	3.55	0.39	2.53	0.24	71.44	71.87
Grain36	3	3284.06	3.28E-05	91350.34	2.41	0.19	2.66	0.16	72.84	84.3
Grain37	3	3353.67	3.35E-05	89454.11	3.49	0.37	2.38	0.29	49.34	57.21
Grain38	2	4858.43	4.86E-05	41165.55	2.26	0.22	2.86	0.12	35.03	49.65
Grain39	3	2696.89	2.70E-05	111239.19	2.78	0.42	2.87	0.24	76.78	89.41
Grain40	1	2669.52	2.67E-05	37459.97	3.29	0.50	2.94	0.00	21.94	44
Length data: Cf source										
Length Name	Length Number	Fission Track type	Apparent Length (μm)	Angle to C-axis ($^\circ$)	Mean Dpar (μm)	Dpar SD/SE (μm)	Dip ($^\circ$)	Corrected Z Depth (μm)	True Length (μm)	
Length01	1	T	14.82	69.86	2.41	0.00	3.80	0.98	14.85	
Length02	1	T	14.37	49.18	2.59	0.08	0.00	0.00	14.37	
Length04	1	T	14.00	60.38	2.86	0.09	0.00	0.00	14.00	
Length05	1	T	15.82	81.35	2.58	0.07	0.00	0.00	15.82	
Length07	1	T	10.92	77.59	2.44	0.04	0.00	0.00	10.92	
Length08	1	T	14.44	35.45	2.36	0.26	5.85	1.47	14.51	
Length09	1	T	13.42	45.23	2.17	0.08	0.00	0.00	13.42	
Length10	1	T	12.55	31.51	2.77	0.06	9.00	1.96	12.70	
Length11	1	T	12.28	12.34	2.79	0.00	6.88	1.47	12.37	
Length12	1	T	13.26	69.94	2.46	0.17	21.73	4.91	14.14	
Length13	1	T	14.77	47.21	2.61	0.14	0.00	0.00	14.77	
Length13	2	T	12.98	79.87	2.61	0.14	10.90	2.45	13.21	
Length14	1	T	15.64	66.59	2.43	0.31	14.54	3.93	16.12	
Length15	1	T	13.57	43.51	2.80	0.06	6.23	1.47	13.65	
Length16	1	T	15.52	52.07	2.65	0.08	0.00	0.00	15.52	

SAMPLE: 160-13										
Count data:										
Grain ID	Ns	A (μm^2)	A (cm^2)	ρ_s (n/cm^2)	238U content	238U 2SE (ppm)	Dpar (μm)	Dpar SD (μm)	Single-grain Age (Ma)	Age 2SE (Ma)
Grain02	5	2002.73	2.00E-05	249659.35			3.93	0.10		
Grain03	32	3079.14	3.08E-05	1039252.07	86.20	19.90	3.83	0.36	23.24	9.81
Grain04	15	2915.69	2.92E-05	514458.59	57.42	13.78	4.21	0.27	17.28	9.84
Grain05	18	3910.90	3.91E-05	460251.98	65.51	14.05	4.07	0.27	13.55	7.02
Grain06	27	5083.04	5.08E-05	531178.10	66.80	15.06	4.48	0.44	15.34	6.84
Grain07	22	4086.05	4.09E-05	538417.42	67.45	15.13	4.33	0.21	15.40	7.42
Grain08	22	2521.76	2.52E-05	872407.26	81.26	19.53	4.23	0.36	20.70	10.13
Grain09	16	1788.78	1.79E-05	894466.66	79.32	22.16	4.47	0.26	21.74	12.45
Grain10	14	2015.71	2.02E-05	694543.24	81.73	18.65	4.12	0.04	16.39	9.53
Grain11	13	2130.61	2.13E-05	610154.92	101.46	24.30	3.93	0.24	11.60	7.01
Grain12	35	5405.35	5.41E-05	647506.18	78.36	18.04	3.85	0.17	15.94	6.52
Grain13	17	3943.30	3.94E-05	431110.82	45.55	10.16	4.09	0.30	18.25	9.75
Grain14	24	3558.02	3.56E-05	674532.01	47.26	10.71	3.79	0.16	27.50	12.84
Grain15	28	5376.05	5.38E-05	520828.47	57.46	13.34	3.77	0.54	17.48	7.75
Grain16	34	5345.90	5.35E-05	636001.08	94.94	23.62	3.73	0.32	12.92	5.48
Grain17	36	6123.92	6.12E-05	587858.93	73.19	17.02	3.68	0.06	15.49	6.30
Grain18	25	4267.68	4.27E-05	585797.72	73.24	15.88	3.50	0.23	15.43	7.02
Grain19	20	2552.52	2.55E-05	783538.45	73.95	16.81	3.43	0.06	20.43	10.25
Grain20	16	2422.58	2.42E-05	660453.01	74.16	17.12	3.39	0.12	17.18	9.46
Grain21	15	2750.71	2.75E-05	545313.22	89.40	21.20	3.66	0.20	11.77	6.69
Grain22	23	4629.53	4.63E-05	496810.96	49.45	8.91	4.14	0.18	19.37	8.80
Grain23	42	7108.52	7.11E-05	590840.26	37.02	4.55	4.51	0.56	30.75	10.21
Grain24	21	2914.56	2.91E-05	720519.72	80.18	18.77	4.03	0.46	17.33	8.58
Grain25	15	2137.97	2.14E-05	701598.75	79.28	17.67	4.08	0.03	17.07	9.60
Grain26	16	2632.47	2.63E-05	607795.01	70.26	16.10	4.22	0.25	16.68	9.18
Grain27	29	5023.83	5.02E-05	577248.34	77.62	17.25	4.80	0.14	14.35	6.21
Grain28	19	5098.38	5.10E-05	372667.68	57.05	18.98	4.27	0.54	12.60	7.14
Grain29	31	6739.63	6.74E-05	459965.64	82.24	18.05	4.30	0.16	10.79	4.54
Grain30	16	2023.42	2.02E-05	790739.34			3.72	0.29		
Grain31	17	3419.11	3.42E-05	497205.87	49.75	10.68	4.36	0.35	19.27	10.22
Grain32	42	8123.13	8.12E-05	517042.05	88.11	20.22	4.66	0.23	11.32	4.35
Grain33	39	5491.96	5.49E-05	710128.39	94.57	23.91	4.61	0.06	14.48	5.91
Grain34	18	8182.24	8.18E-05	219988.70	38.60	8.22	4.55	0.16	11.00	5.69
Grain35	30	4709.91	4.71E-05	636955.37	67.30	14.19	4.31	0.18	18.25	7.69
Grain36	41	5409.77	5.41E-05	757887.53	79.77	16.84	4.56	0.52	18.32	6.91

Length data:									
Length Name	Length Number	Fission Track type	Apparent Length (µm)	Angle to C-axis (°)	Mean Dpar (µm)	Dpar SD/SE (µm)	Dip (°)	Corrected Z Depth (µm)	True Length (µm)
Length01	1	C	14.19	83.35	4.37	0.07	3.97	0.98	14.22
Length01	2	C	13.38	78.52	4.37	0.07	2.10	0.49	13.39
Length01	3	C	15.50	69.17	4.37	0.07	0.00	0.00	15.50
Length02	1	T	13.35	25.80	3.74	0.36	10.59	2.45	13.57
Length02	2	T	11.30	48.80	3.74	0.36	2.49	0.49	11.31
Length03	1	C	14.83	31.09	2.55	0.45	5.70	1.47	14.91
Length04	1	T	13.04	60.38	4.10	0.23	4.32	0.98	13.08
Length06	1	T	13.40	53.76	3.53	0.05	0.00	0.00	13.40
Length06	2	T	10.27	10.21	3.53	0.05	8.24	1.47	10.38
Length07	1	T	12.80	69.32	3.09	0.43	2.20	0.49	12.81
Length08	1	C	13.90	62.32	4.16	0.12	2.02	0.49	13.91
Length10	1	C	12.37	52.07	4.22	0.15	4.55	0.98	12.41
Length11	1	T	12.93	63.70	3.90	1.29	4.36	0.98	12.96
Length12	1	T	13.57	68.11	4.28	0.06	12.53	2.94	13.89
Length13	1	T	14.43	49.13	4.30	0.06	11.77	2.94	14.73
Length14	1	C	13.94	55.75	4.50	0.00	8.09	1.96	14.08
Length15	1	C	13.73	87.91	3.56	0.44	4.10	0.98	13.76
Length16	1	T	13.04	32.43	3.79	0.00	2.16	0.49	13.05
Length17	1	T	15.10	46.39	4.03	0.18	9.35	2.45	15.30
Length18	1	C	14.57	74.38	3.76	0.27	3.86	0.98	14.60
Length19	1	C	14.31	38.76	3.38	0.09	5.91	1.47	14.39
Length20	1	T	10.65	78.19	3.86	0.06	10.62	1.96	10.83
Length20	2	T	13.81	77.66	3.86	0.06	2.04	0.49	13.82
Length21	1	T	12.58	66.74	3.98	0.16	18.18	3.93	13.18
Length21	2	T	10.93	0.80	3.98	0.16	0.00	0.00	10.93
Length22	1	T	12.78	70.01	3.69	0.59	8.83	1.96	12.93
Length23	1	C	12.58	85.36	2.77	0.39	2.24	0.49	12.58
Length23	2	C	11.51	87.20	2.77	0.39	7.35	1.47	11.60
Length24	1	T	13.39	67.76	3.91	0.14	4.21	0.98	13.42
Length24	2	T	13.22	57.44	3.91	0.14	4.26	0.98	13.26
Length25	1	C	13.49	88.55	4.05	0.00	6.27	1.47	13.57
Length26	1	T	13.57	33.29	4.28	0.19	4.15	0.98	13.60
Length27	1	T	14.08	66.04	3.84	0.10	6.00	1.47	14.16
Length28	1	T	12.43	63.02	3.92	0.08	16.04	3.44	12.90
Length29	1	T	14.92	61.72	3.33	0.18	5.67	1.47	14.99
Length30	1	C	15.42	78.99	4.05	0.13	9.16	2.45	15.61
Length32	1	T	12.78	49.10	4.20	0.13	13.33	2.94	13.11
Length33	1	C	14.39	89.05	3.77	0.00	7.84	1.96	14.52
Length34	1	T	15.48	74.91	3.89	0.23	9.12	2.45	15.67
Length35	1	C	14.52	47.91	4.02	0.01	11.70	2.94	14.82
Length36	1	T	14.58	81.66	3.79	0.23	3.86	0.98	14.61
Length37	1	C	14.26	54.51	3.78	0.00	5.93	1.47	14.34
Length38	1	T	14.70	89.52	3.95	0.10	1.91	0.49	14.71
Length39	1	T	14.53	81.47	3.74	0.00	1.94	0.49	14.53
Length40	1	T	13.91	76.74	3.64	0.14	8.11	1.96	14.05
Length41	1	C	14.92	89.50	3.98	0.50	7.56	1.96	15.05
Length42	1	T	15.01	83.91	3.99	0.15	9.41	2.45	15.21
Length43	1	T	14.18	63.81	3.53	0.24	0.00	0.00	14.18
Length44	1	T	14.29	39.53	3.77	0.27	7.90	1.96	14.42
Length44	2	T	13.65	47.16	3.77	0.27	0.00	0.00	13.65
Length45	1	T	14.22	30.83	3.89	0.06	1.98	0.49	14.22
Length46	1	T	12.73	48.21	3.75	0.00	2.21	0.49	12.74
Length46	2	T	14.03	81.83	3.75	0.00	14.17	3.44	14.45
Length47	1	T	13.23	43.83	3.16	0.09	6.39	1.47	13.31
Length48	1	C	13.88	88.31	3.99	0.25	0.00	0.00	13.88
Length49	1	T	15.27	21.24	3.39	0.17	5.53	1.47	15.34
Length50	1	T	12.81	73.47	3.47	0.50	0.00	0.00	12.81
Length51	1	C	14.03	56.54	3.85	0.11	4.01	0.98	14.06
Length52	1	C	10.91	89.36	3.55	0.12	5.16	0.98	10.96
Length53	1	T	12.02	63.36	3.78	0.35	2.34	0.49	12.03
Length54	1	T	15.63	42.07	3.79	0.29	1.80	0.49	15.64
Length55	1	T	14.76	84.76	3.56	0.21	21.45	5.40	15.72
Length56	1	T	12.60	66.03	3.62	0.14	13.51	2.94	12.94
Length56	1	C	12.00	77.73	3.62	0.14	7.05	1.47	12.09
Length57	1	T	13.38	82.87	3.42	0.11	0.00	0.00	13.38
Length58	1	T	14.03	80.19	3.74	0.25	14.17	3.44	14.45
Length59	1	C	13.57	89.78	3.90	0.00	14.67	3.44	14.00
Length60	1	C	13.51	46.28	2.86	0.18	16.90	3.93	14.07
Length61	1	C	12.60	80.27	2.88	0.00	6.71	1.47	12.69
Length61	2	C	15.30	78.07	2.88	0.00	5.52	1.47	15.37
Length63	1	T	13.56	49.12	4.15	0.12	2.07	0.49	13.57
Length64	1	T	13.75	35.63	3.51	0.76	10.28	2.45	13.97
Length66	1	T	11.39	53.69	3.70	0.12	2.47	0.49	11.41
Length67	1	T	12.02	49.01	3.44	0.31	9.40	1.96	12.18
Length67	1	C	13.34	84.77	3.44	0.31	23.86	5.40	14.39
Length68	1	C	13.73	60.92	4.19	0.07	3.82	0.98	14.76
Length68	2	C	13.47	57.98	4.19	0.07	12.63	2.94	13.78
Length68	3	C	13.12	83.80	4.19	0.07	12.97	2.94	13.45
Length69	1	C	13.36	64.95	4.15	0.26	2.11	0.49	13.37
Length69	2	C	14.14	56.23	4.15	0.26	1.99	0.49	14.14
Length69	3	C	14.61	83.53	4.15	0.26	3.85	0.98	14.65
Length69	4	C	13.51	56.56	4.15	0.26	10.46	2.45	13.73
Length70	1	T	15.75	44.93	3.51	0.69	7.16	1.96	15.87
Length71	1	T	12.70	59.32	3.57	0.38	6.66	1.47	12.79
Length71	2	T	12.18	71.74	3.57	0.38	11.63	2.45	12.42
Length72	1	T	14.19	59.53	4.62	0.24	11.98	2.94	14.49
Length73	1	T	13.34	75.88	4.60	0.03	8.46	1.96	13.48
Length73	2	T	9.73	25.59	4.60	0.03	8.71	1.47	9.84
Length74	1	T	13.96	76.25	4.23	0.17	4.03	0.98	13.99
Length75	1	T	13.33	29.52	3.75	0.17	2.11	0.49	13.34
Length76	1	T	13.96	75.07	3.67	0.39	20.58	4.91	14.80
Length77	1	T	13.30	68.54	3.96	0.01	4.23	0.98	13.33
Length77	2	T	15.46	86.02	3.96	0.01	1.82	0.49	15.47
Length78	1	T	13.72	39.64	3.62	0.06	0.00	0.00	13.72
Length79	1	T	12.69	76.08	3.95	0.54	13.41	2.94	13.03
Length80	1	T	14.71	40.76	4.67	0.42	5.75	1.47	14.78
Length81	1	T	13.51	67.12	4.38	0.00	6.26	1.47	13.59
Length81	2	T	12.67	77.45	4.38	0.00	6.67	1.47	12.76
Length82	1	T	13.82	38.12	4.29	0.20	10.22	2.45	14.04
Length83	1	T	12.70	76.96	4.35	0.14	8.89	1.96	12.85
Length84	1	T	14.64	52.88	3.76	0.12	0.00	0.00	14.64
Length85	1	T	12.84	72.44	3.88	0.55	27.31	5.89	14.12
Length86	1	T	15.22	54.62	3.82	0.06	9.28	2.45	15.42
Length87	1	T	13.79	48.10	4.04	0.00	0.00	0.00	13.79
Length88	1	T	14.18	32.05	4.58	0.19	0.00	0.00	14.18
Length88	2	T	13.98	76.72	4.58	0.19	4.03	0.98	14.02
Length90	1	T	13.10	35.66	4.56	0.45	6.45	1.47	13.18
Length90	2	T	14.64	85.57	4.56	0.45	0.00	0.00	14.64
Length91	1	C	13.96	48.81	4.64	0.07	0.00	0.00	13.96

SAMPLE: 160-14										
Count data:										
Grain ID	Ns	A (μm^2)	A (cm^2)	ρ_s (n/cm^2)	^{238}U content	^{238}U 2SE (ppm)	Dpar (μm)	Dpar SD (μm)	Single-grain Age (Ma)	Age 2SE (Ma)
Grain01	3	1.21E-05	247580.11			2.71	0.63			
Grain02	1	7.74E-06	129166.78			2.94	0.16			
Grain03	4	2.76E-05	145047.61			3.91	0.29			
Grain04	4	2.77E-05	144588.91			3.55	0.48			
Grain05	3	1.61E-05	185997.20			3.27	0.25			
Grain06	3	3.66E-05	82068.40			3.11	0.20			
Grain07	3	1.26E-05	238175.50			2.98	0.53			
Grain08	4	2.18E-05	183281.55			3.22	0.21			
Grain09	1	1.46E-05	68296.16			3.60	0.00			
Grain10	5	2.61E-05	191689.89			3.94	0.35			
Grain11	4	3.78E-05	105908.14			3.28	0.06			
Grain12	2	1.34E-05	149780.41			3.08	0.02			
Grain13	2	8.53E-06	234463.30			3.46	0.29			
Grain14	2	1.70E-05	117308.06			3.20	0.19			
Grain15	2	1.65E-05	121050.93			3.20	0.45			
Grain16	3	1.90E-05	158284.55			2.68	0.28			
Length data:										
Length Name	Length Number	Fission Track type	Apparent Length (μm)	Angle to C-axis ($^\circ$)	Mean Dpar (μm)	Dpar SD/SE (μm)	Dip ($^\circ$)	Corrected Z Depth (μm)	True Length (μm)	
Length01	1	C	12.48	49.11	3.22	0.64	2.25	0.49	12.49	
Length02	1	C	13.48	59.92	3.54	1.08	0.00	0.00	13.48	
Length03	1	C	13.53	53.65	3.62	0.00	12.57	2.94	13.85	
Length04	1	C	14.23	29.91	2.73	0.10	7.93	1.96	14.37	
Length04	2	C	15.29	50.63	2.73	0.10	22.65	5.89	16.39	

SAMPLE: 160-15										
Count data:										
Grain ID	Ns	A (um2)	A (cm2)	ps (n/cm-2)	238U content	238U 2SE (ppm)	Dpar (μm)	Dpar SD (μm)	Single-grain Age (Ma)	Age 2SE (Ma)
Grain01	31	3541.18	3.54E-05	875415.03	26.67	5.96	2.05	0.13	63.07	26.69
Grain02	6	888.01	8.88E-06	675667.54			2.02	0.16		
Grain03	8	5645.75	5.65E-05	141699.54	15.54	2.95	3.35	0.47	17.58	12.87
Grain04	0	0.00	0.00E+00	0.00			1.74	0.45		
Grain05	1	1788.37	1.79E-05	55916.75			1.85	0.00		
Grain06	8	7187.66	7.19E-05	111301.84	11.60	0.98	2.29	0.73	18.50	13.17
Grain07	1	2365.19	2.37E-05	42279.93			2.23	0.00		
Grain08	4	1933.42	1.93E-05	206887.09			2.09	0.21		
Grain09	2	1897.48	1.90E-05	105402.85	2.16	0.29	2.88	0.11	93.75	133.2
Grain10	5	3532.37	3.53E-05	141548.19	25.72	12.94	2.45	0.15	10.62	10.9
Grain11	7	3228.67	3.23E-05	216807.66			2.08	0.22		
Grain12	2	4002.15	4.00E-05	49973.08			2.21	0.02		
Grain13	1	2327.49	2.33E-05	42964.70	10.87	1.88	1.83	0.03	7.63	15.32
Grain14	2	946.06	9.46E-06	211404.04			1.79	0.00		
Grain15	3	4665.94	4.67E-05	64295.66			2.19	0.20		
Grain16	1	5155.32	5.16E-05	19397.43			2.08	0.20		
Grain17	1	538.86	5.39E-06	185578.43			1.97	0.12		
Grain18	3	1480.84	1.48E-05	202588.24			2.02	0.32		
Grain19	5	3652.67	3.65E-05	136886.07	11.08	1.12	2.25	0.35	23.81	21.43
					14.81	4.4710609				
Length data:										
Length Name	Length Number	Fission Track type	Apparent Length (μm)	Angle to C-axis (°)	Mean Dpar (μm)	Dpar SD/SE (μm)	Dip (°)	Corrected Z Depth (μm)	True Length (μm)	
Length01	1	C	12.42	78.78	1.84	0.06	2.26	0.49	12.43	
Length01	2	C	14.83	39.33	1.84	0.06	5.70	1.47	14.90	
Length02	1	C	12.56	63.22	1.91	0.05	4.48	0.98	12.59	
Length02	2	C	11.51	84.25	1.91	0.05	7.35	1.47	11.60	
Length02	3	C	10.98	68.95	1.91	0.05	2.56	0.49	10.99	
Length02	4	C	10.84	44.19	1.91	0.05	2.60	0.49	10.85	
Length03	1	C	11.44	77.88	2.01	0.11	2.46	0.49	11.45	
Length04	1	C	10.26	70.10	1.78	0.16	0.00	0.00	10.26	
Length05	1	C	13.29	49.06	1.98	0.00	10.64	2.45	13.52	
Length06	1	C	13.81	50.45	1.98	0.00	16.52	3.93	14.36	
Length07	1	C	12.58	74.99	1.77	0.00	0.00	0.00	12.58	
Length08	1	C	9.65	25.61	1.62	0.19	8.77	1.47	9.77	
Length09	1	T	14.32	42.61	2.18	0.14	7.88	1.96	14.46	

Table B.3: Single grain apatite (U-Th)/He data (AHe).

Note
a - Length is measured parallel to the c-axis and includes pyramidal terminations. It is measured twice on two perpendicular sides.
b - Width 1 is measured perpendicular to the c-axis. Width 2 is measured perpendicular to both the c-axis and width 1.
c - Geometry is defined as described as in Figure 3 of Ketcham et al. (2011). 1 is ellipsoid, 2 is cylinder, 3 is tetrahedral prism, and 4 is hexagonal prism
d - Np denotes the number of pyramidal terminations of the grain.
e - Blank-corrected ^4He
f - Uncertainties on ^4He , U, Th, and Sm are reported at 2σ standard deviations and include the propagated uncertainties on the measurements of the sample, blank, isotopic spike, and calibration standard.
g - Total blank-corrected ng of ^{238}U and ^{235}U . Total ^{238}U is measured and ^{235}U is calculated assuming $^{235}\text{U} = ^{238}\text{U}/137.818$ after Hiess et al. (2012).
h - Total blank-corrected ng of ^{232}Th
i - Total blank-corrected ng of ^{147}Sm . Sm is determined using a total analysis approach
j - Rs is the radius of a sphere with an equivalent alpha-ejection correction as the grain, calculated using Ketcham et al. (2011).
k - Mass is the mass of the crystal. Determined from the measured grain dimensions, the volume assuming the reported grain geometry, and the volume equations and mineral densities in Ketcham et al. (2011).
l - Concentration of each element (He, U, Th and Sm) computed from the absolute amount of the measured isotopes (where ^{147}Sm is 0.15 of the total Sm reported here) and the estimated dimensional mass. In some cases Sm may not be measured, for example in minerals like zircon with negligible Sm.
m - Uncertainties on U, Th, Sm, and He concentrations are reported at 2s and include the propagated total analytical uncertainties (TAU).
n - eU is effective uranium concentration. Calculated as $U + 0.238*\text{Th} + 0.0012*\text{Sm}$ after Appendix A of Cooperdock et al. (2019).
o - Uncertainty on eU is calculated as the quadratic sum of the uncertainties in U, Th, and Sm concentrations weighted by their relative contributions
p - Uncorrected (U-Th)/He date is calculated iteratively using the first two terms of a Taylor expansion of the age equation (linear approximation)
q - Uncertainty on the uncorrected (U-Th)/He date is reported at 2s and includes the propagated total analytical uncertainties (TAU) on the U, Th, Sm and He measurements.
r - Alpha-ejection correction for the crystal calculated using the proportion of U and Th contributing to ^4He production, and assuming homogeneous parent isotope distributions using Ketcham et al. (2011).
s - Corrected date calculated using the uncorrected date and the F_T correction factor
t - Uncertainty on the corrected (U-Th)/He date is reported at 2s and includes the propagated total analytical uncertainties (TAU) on the U, Th, Sm and He measurements.

Field ID	Aliquot	Length 1 (μm) ^a	Width 1 (μm) ^a	Length 2 (μm) ^a	Width 2 (μm) ^a	Geometry ^c	Np ^d	⁴ He (fmol) ^e	$\pm$ fmol ABS ^f	$\pm$ ng (2 σ , ABS) ^g	U (ng) ^h	$\pm$ ng (2 σ , ABS) ^h	Th (ng) ⁱ	$\pm$ ng (2 σ , ABS) ^j	Sm (ng) ^k	$\pm$ ng (2 σ , ABS) ^j	Th/U
VI2208	160-01-1	200.733	123.854	196.217	111.126	4	2p	11.638	0.075	0.064	0.003	0.105	0.004	0.588	0.016	1.634	
	160-01-2	184.144	108.413	186.041	99.050	4	2p	7.652	0.050	0.051	0.002	0.081	0.003	0.433	0.012	1.585	
	160-01-3	169.644	101.898	166.934	103.099	4	2p	14.201	0.170	0.077	0.003	0.117	0.004	0.470	0.012	1.507	
	160-01-4	156.075	83.375	159.301	82.006	4	1p	3.613	0.086	0.027	0.002	0.051	0.002	0.390	0.012	1.868	
	160-01-5	167.027	97.171	172.984	91.615	4	2p	6.328	0.091	0.044	0.002	0.063	0.002	0.365	0.011	1.431	
VI2211	160-02-1	134.694	68.418	138.618	56.002	4	2p	0.425	0.079	0.005	0.001	0.014	0.001	0.170	0.007	2.942	
	160-02-2	127.790	68.028	129.846	59.874	4	2p	0.495	0.030	0.003	0.000	0.007	0.001	0.140	0.004	2.160	
	160-02-3	139.160	67.566	142.668	69.122	4	2p	1.089	0.037	0.004	0.000	0.013	0.001	0.164	0.005	3.233	
	160-02-4	157.376	79.256	163.482	75.577	4	2p	0.862	0.033	0.006	0.001	0.022	0.001	0.227	0.009	3.833	
	160-02-5	133.450	90.376	129.519	84.453	4	2p	1.390	0.031	0.010	0.001	0.020	0.001	0.224	0.013	1.996	
VI2206	160-03-1	142.908	66.562	141.019	58.627	4	2p	0.945	0.022	0.004	0.001	0.014	0.001	0.294	0.013	3.156	
	160-03-2	107.545	70.890	106.854	70.605	4	2p	1.701	0.030	0.009	0.001	0.021	0.001	0.261	0.009	2.232	
	160-03-3	116.412	68.503	116.631	55.624	4	1p	0.670	0.022	0.003	0.000	0.011	0.001	0.229	0.008	3.465	
	160-03-4	115.887	73.080	114.117	79.331	4	2p	0.736	0.023	0.004	0.002	0.013	0.003	0.216	0.009	3.380	
	160-03-5	134.213	86.872	131.317	86.252	4	1p	0.939	0.049	0.006	0.000	0.018	0.001	0.342	0.013	3.195	
DC0640	160-04-1	95.330	72.255	94.113	58.924	4	2p	2.676	0.062	0.022	0.002	0.035	0.002	0.200	0.007	1.616	
	160-04-2	129.259	58.731	126.563	60.976	4	2p	6.328	0.061	0.023	0.001	0.049	0.002	0.326	0.007	2.120	
	160-04-3	116.019	73.611	117.314	62.883	4	2p	3.125	0.077	0.025	0.001	0.056	0.002	0.322	0.014	2.258	
	160-04-4	116.807	67.487	117.342	50.950	4	2p	2.436	0.084	0.021	0.004	0.036	0.003	0.278	0.029	1.729	
	160-04-5	116.476	60.973	116.558	61.606	4	2p	3.403	0.035	0.025	0.001	0.049	0.002	0.254	0.011	1.962	
DC0645	160-05-1	132.090	85.993	133.795	83.132	4	2p	2.642	0.036	0.028	0.001	0.025	0.001	0.333	0.013	0.879	
	160-05-2	131.751	79.830	131.749	80.769	4	1p	2.249	0.034	0.020	0.001	0.015	0.001	0.319	0.008	0.726	
	160-05-3	132.918	81.940	136.059	74.322	4	1p	3.014	0.110	0.024	0.001	0.019	0.001	0.396	0.011	0.809	
	160-05-4	157.663	65.617	157.274	62.377	4	no p	1.269	0.015	0.010	0.001	0.009	0.001	0.227	0.008	0.869	
	160-05-5	141.800	78.439	139.852	76.293	4	no p	1.938	0.020	0.018	0.002	0.016	0.001	0.302	0.009	0.904	
DC0703	160-06-1	114.180	76.269	115.037	69.217	4	2p	0.754	0.041	0.009	0.001	0.015	0.001	0.082	0.004	1.747	
	160-06-2	143.647	80.095	142.478	78.288	4	1p	0.450	0.015	0.009	0.000	0.023	0.001	0.114	0.006	2.630	
	160-06-3	135.718	86.205	135.954	80.680	4	2p	0.523	0.015	0.010	0.001	0.024	0.001	0.129	0.005	2.291	
	160-06-4	142.478	78.677	146.352	79.830	4	1p	0.728	0.017	0.010	0.001	0.016	0.001	0.108	0.005	1.549	
	160-06-5	131.707	84.234	127.094	68.761	4	2p	0.790	0.011	0.013	0.001	0.022	0.001	0.120	0.005	1.741	
DC2101	160-07-1	124.838	65.881	126.019	56.326	4	no p	0.130	0.048	0.001	0.000	0.001	0.001	0.059	0.002	2.430	
	160-07-2	145.230	67.471	141.200	66.805	4	no p	0.282	0.017	0.001	0.000	0.002	0.000	0.130	0.005	1.653	
	160-07-3	131.913	58.586	133.701	52.206	4	2p	0.138	0.017	0.001	0.000	0.002	0.001	0.086	0.003	1.675	
	160-07-4	131.191	68.740	134.253	69.392	4	2p	0.704	0.024	0.004	0.000	0.010	0.001	0.113	0.003	2.473	
	160-07-5	219.365	95.844	218.485	95.853	4	2p	0.839	0.042	0.004	0.001	0.007	0.001	0.320	0.011	1.692	
CS1093	160-08-1	119.017	70.916	119.262	73.809	4	1p	3.418	0.106	0.025	0.001	0.023	0.001	0.413	0.013	0.896	
	160-08-2	112.924	67.224	109.261	77.220	4	1p	2.758	0.073	0.022	0.001	0.026	0.002	0.451	0.012	1.214	
	160-08-3	125.793	92.213	127.266	73.855	4	2p	3.706	0.082	0.029	0.002	0.027	0.001	0.546	0.012	0.923	
	160-08-4	202.701	82.432	202.845	81.585	4	1p	6.370	0.064	0.042	0.002	0.045	0.002	0.998	0.026	1.064	
	160-08-5	133.415	76.676	134.350	69.128	4	2p	2.631	0.054	0.024	0.001	0.028	0.002	0.471	0.011	1.138	
JL0678	160-09-1	116.371	87.089	113.912	79.674	4	no p	1.024	0.016	0.005	0.001	0.010	0.001	0.202	0.007	2.034	
	160-09-2	118.228	82.114	117.340	81.408	4	1p1b	0.987	0.016	0.004	0.000	0.007	0.001	0.146	0.007	1.935	
	160-09-3	132.482	69.985	131.619	65.095	4	no p	1.292	0.018	0.004	0.000	0.007	0.001	0.162	0.008	1.910	
	160-09-4	128.799	78.100	127.554	65.972	4	2p	0.777	0.104	0.004	0.000	0.008	0.001	0.182	0.005	1.969	
	160-09-5	130.532	72.001	132.217	67.128	4	no p	1.204	0.104	0.005	0.001	0.010	0.001	0.179	0.008	1.850	
JL0625	160-10-1	130.335	75.986	132.919	68.963	4	2p	1.831	0.019	0.014	0.001	0.007	0.001	0.119	0.007	0.492	
	160-10-2	107.584	67.447	107.663	61.318	4	2p	1.718	0.025	0.013	0.001	0.006	0.001	0.088	0.004	0.463	
	160-10-3	149.996	64.777	149.475	61.905	4	2p	0.908	0.029	0.010	0.001	0.006	0.001	0.115	0.007	0.563	
	160-10-4	120.294	45.487	119.577	57.199	4	2p	0.664	0.029	0.006	0.000	0.003	0.001	0.051	0.006	0.524	
	160-10-5	91.205	62.784	94.282	55.401	4	2p	1.077	0.035	0.012	0.001	0.006	0.001	0.065	0.006	0.500	
DCMD04	160-13-1	120.760	87.912	121.506	83.253	4	1p	14.624	0.135	0.069	0.003	0.155	0.009	0.206	0.006	2.259	
	160-13-2	131.603	82.680	130.825	85.266	4	no p	17.123	0.133	0.109	0.004	0.078	0.005	0.138	0.004	0.716	
	160-13-3	138.089	76.546	140.606	74.980	4	no p	13.049	0.091	0.080	0.004	0.076	0.004	0.183	0.010	0.948	
	160-13-4	134.903	86.551	137.197	77.078	4	2p	12.485	0.083	0.068	0.003	0.144	0.007	0.170	0.005	2.121	
	160-13-5	182.247	100.741	182.268	77.528	4	1p	22.969	0.126	0.149	0.007	0.104	0.006	0.297	0.010	0.698	
DC2201	160-14-1	161.119	105.058	157.603	95.508	4	1p	22.969	0.050	0.012	0.001	0.029	0.002	0.405	0.013	2.355	
	160-14-2	138.129	79.693	139.152	71.786	4	1p	1.217	0.042	0.008	0.001	0.014	0.001	0.163	0.004	1.830	
	160-14-3	134.859	91.443	134.719	85.692	4	2p	1.070	0.032	0.006	0.000	0.015	0.001	0.209	0.004	2.442	
	160-14-4	132.234	101.953	134.546	100.452	4	1p1b	1.781	0.038	0.010	0.001	0.021	0.001	0.314	0.007	2.079	
	160-14-5	167.163	100.152	170.441	86.653	4	1p1b	1.760	0.031	0.010	0.001	0.030	0.002	0.366	0.012	2.860	
MW2020	160-17-1	168.100	104.677	164.100	105.530	4	1p1b	1.681	0.044	0.009	0.000	0.019	0.001			2.2	
	160-17-2	145.100	87.803	139.700	90.210	4	2b	0.950	0.029	0.004	0.000	0.006	0.000			1.8	
	160-17-3	192.600	74.493	190.300	73.420	4	2b	0.704	0.026	0.003	0.000	0.004	0.000			1.3	
	160-17-4	181.600	79.477	176.100	79.897	4	2b	0.934	0.026	0.005	0.0						

Field ID	Rs (μm) ^f	Mass (μg) ^h	³ He (fmol/μg) ^g	± (2σ, ABS) ^j	[U] (mg/kg) ⁱ	± (2σ, ABS) ^j	[Th] (mg/kg) ⁱ	± (2σ, ABS) ^j	[Sm] (mg/kg) ⁱ	± (2σ, ABS) ^j	eU (mg/kg) ^g	± (2σ, ABS) ^j	Uncorr Date (Ma) ^f	± (2σ, ABS) ^j	F _i ^l	Corr Date (Ma) ^f	± (2σ, ABS) ^j
VI2208	60.8	4.06	2.86642		15.827	0.653	25.855	1.076	144.930	3.830	22.15	1.28	23.99	0.8	0.76	31.4	1.0
	54.6	3.01	2.54224	0.02	17.003	0.597	26.947	1.068	143.881	4.101	23.59	1.25	19.99	0.5	0.74	27.0	0.7
	52.4	2.56	5.54720	0.07	30.218	1.007	45.528	1.505	183.496	4.629	41.27	2.09	24.92	0.7	0.73	34.2	0.9
	45	2.09	1.72880	0.04	13.106	0.746	24.481	0.922	186.518	5.939	19.16	1.32	16.74	0.8	0.69	24.3	1.1
	50.1	2.35	2.69264	0.04	18.647	0.901	26.680	0.740	155.404	4.770	25.18	1.54	19.83	0.8	0.72	27.6	1.0
VI2211	34.8	0.89	0.47779	0.09	5.275	0.666	15.520	1.192	190.847	8.124	9.20	1.25	9.64	1.9	0.60	16.2	3.2
	35	0.85	0.58206	0.04	3.866	0.357	8.353	1.138	164.674	4.966	6.05	0.72	17.84	1.7	0.60	29.6	2.8
	37.6	1.07	1.01816	0.04	3.856	0.394	12.468	0.644	153.671	5.107	7.01	0.78	26.94	1.8	0.62	43.2	2.9
	42.8	1.59	0.54219	0.02	3.554	0.372	13.622	0.740	143.055	5.797	6.97	0.79	14.44	1.0	0.66	21.8	1.5
	43.2	1.4	0.99309	0.02	7.169	0.512	14.308	0.843	159.786	9.638	10.77	0.91	17.11	0.9	0.67	25.4	1.4
VI2206	35.2	0.94	1.00495	0.02	4.591	0.635	14.490	1.145	312.460	13.570	8.41	1.24	22.15	1.8	0.60	36.9	3.1
	34.9	0.73	2.32946	0.04	12.958	0.836	28.919	1.448	358.048	12.251	20.27	1.56	21.32	1.0	0.60	35.4	1.7
	33.6	0.86	0.77914	0.03	3.560	0.356	12.338	0.993	265.878	9.293	6.82	0.77	21.21	1.5	0.59	36.1	2.5
	37.6	0.92	0.80013	0.02	4.048	1.708	13.681	2.859	234.482	9.822	7.59	3.30	19.57	4.6	0.62	31.4	7.4
	44.5	1.84	0.51060	0.03	3.048	0.194	9.737	0.569	185.932	6.812	5.59	0.44	16.95	1.1	0.68	24.9	1.7
DC0640	31.7	0.54	4.95480	0.11	40.644	3.519	65.675	3.206	370.758	13.355	56.72	5.46	16.21	1.1	0.57	28.4	1.9
	33.3	0.76	8.32669	0.08	30.318	1.142	64.270	2.907	428.917	8.794	46.13	2.57	33.45	1.0	0.58	57.3	1.7
	35.4	0.8	3.90577	0.10	30.767	1.711	69.484	2.880	402.488	17.831	47.79	3.28	15.17	0.7	0.61	25.0	1.1
	32.1	0.65	3.74772	0.13	32.298	5.887	55.846	5.304	428.413	44.744	46.10	8.82	15.08	2.0	0.58	26.2	3.4
	32.9	0.68	5.00383	0.05	36.398	1.167	71.422	2.497	373.077	16.626	53.84	2.70	17.24	0.4	0.58	29.7	0.8
DC0645	42.5	1.34	1.97196	0.03	20.933	1.032	18.392	0.960	248.628	9.677	25.61	1.68	14.28	0.6	0.68	21.2	0.9
	42	1.58	1.42320	0.02	12.801	0.658	9.298	0.493	201.994	5.220	15.26	1.02	17.30	0.8	0.68	25.6	1.1
	41.5	1.56	1.93204	0.07	15.356	0.932	12.420	0.600	254.092	7.184	18.62	1.37	19.24	1.2	0.67	28.6	1.7
	36.6	1.47	0.86304	0.01	6.983	0.514	6.070	0.508	154.349	5.711	8.61	0.78	18.58	1.1	0.64	29.2	1.8
	42	1.93	1.00402	0.01	9.176	0.895	8.296	0.426	156.335	4.632	11.34	1.21	16.42	1.3	0.68	24.2	1.9
DC0703	36.5	0.85	0.88728	0.05	10.102	0.888	17.652	1.181	96.421	4.890	14.42	1.44	11.42	0.9	0.62	18.4	1.5
	42.5	1.71	0.26333	0.01	5.003	0.270	13.161	0.735	66.484	3.754	8.22	0.57	5.95	0.3	0.67	8.9	0.5
	42.4	1.35	0.38721	0.01	7.643	0.581	17.512	0.626	95.382	3.454	11.93	1.02	6.03	0.3	0.67	9.0	0.5
	42.7	1.75	0.41625	0.01	5.734	0.466	8.880	0.588	61.913	2.581	7.92	0.75	9.75	0.6	0.68	14.4	0.9
	39.7	1.14	0.69266	0.01	10.977	0.964	19.107	0.833	105.689	4.372	15.65	1.51	8.22	0.5	0.65	12.7	0.8
DC2101	33.9	1.07	0.12177	0.05	0.516	0.105	1.254	0.691	54.918	2.333	0.88	0.30	25.64	11.0	0.60	42.8	18.4
	37.6	1.49	0.18904	0.01	0.991	0.115	1.637	0.216	87.455	3.226	1.49	0.20	23.59	2.4	0.64	37.0	3.8
	31.6	0.7	0.19759	0.02	1.774	0.238	2.972	1.266	122.635	4.525	2.63	0.66	13.94	2.6	0.57	24.5	4.6
	37.3	1	0.70367	0.02	4.127	0.461	10.206	1.167	113.031	2.705	6.69	0.87	19.51	1.7	0.62	31.3	2.7
	54	3.37	0.24885	0.01	1.190	0.190	2.013	0.291	95.102	3.225	1.78	0.32	25.86	3.1	0.74	35.1	4.2
CS1093	37.9	1.16	2.94657	0.09	21.695	1.146	19.449	1.149	356.445	10.926	26.75	1.86	20.42	1.1	0.65	31.7	1.7
	37.2	1.08	2.55349	0.07	20.091	1.041	24.397	1.602	417.388	10.649	26.40	1.85	17.94	0.9	0.64	28.2	1.4
	41.1	1.21	3.06264	0.07	23.971	1.376	22.130	1.171	450.913	9.740	29.78	2.14	19.07	1.0	0.67	28.6	1.4
	46.9	2.72	2.34179	0.02	15.432	0.915	16.419	0.913	366.836	9.596	19.78	1.46	21.95	1.0	0.71	31.1	1.5
	38.7	1.09	2.41402	0.05	22.339	1.294	25.411	1.742	432.217	9.641	28.91	2.18	15.49	0.8	0.65	24.0	1.2
JL0678	42.6	1.84	0.55634	0.01	2.670	0.302	5.430	0.482	109.797	4.049	4.09	0.52	25.19	2.0	0.68	37.2	2.9
	41.1	1.42	0.69501	0.01	2.585	0.165	5.001	0.495	102.813	4.667	3.90	0.34	33.04	1.8	0.71	46.8	2.5
	37.1	1.37	0.94283	0.01	2.801	0.361	5.349	0.562	118.108	5.588	4.22	0.60	41.41	3.7	0.63	65.4	5.9
	37.9	1	0.77652	0.10	4.156	0.428	8.184	0.720	181.919	4.743	6.32	0.74	22.78	3.5	0.63	36.1	5.5
	38	1.46	0.82453	0.07	3.651	0.367	6.756	0.410	122.635	5.682	5.41	0.60	28.27	3.1	0.64	44.0	4.9
JL0625	38.5	1.06	1.72764	0.02	13.175	1.145	6.484	0.683	112.508	7.070	14.85	1.59	21.56	1.6	0.65	33.3	2.5
	33.1	0.65	2.64341	0.04	19.427	1.983	9.004	1.440	135.081	6.110	21.73	2.89	22.54	2.0	0.60	37.8	3.4
	35.9	1.02	0.89035	0.03	9.783	0.780	5.511	0.632	112.423	6.480	11.23	1.16	14.70	1.1	0.62	23.6	1.8
	29.1	0.53	1.25293	0.05	10.991	0.776	5.762	2.069	96.847	10.434	12.48	2.40	18.62	1.6	0.55	34.1	2.9
	29.8	0.46	2.34069	0.08	26.694	1.473	13.351	1.655	141.137	11.999	30.04	2.67	14.45	0.8	0.56	25.9	1.5
DCMD04	42.8	1.59	9.19750	0.08	43.202	1.672	97.584	5.476	129.677	3.823	66.58	3.91	25.62	0.8	0.67	38.1	1.2
	44.1	2.11	8.11537	0.06	51.583	2.063	36.923	2.136	65.447	1.974	60.45	3.62	24.88	0.9	0.70	35.8	1.2
	41.2	1.84	7.09193	0.05	43.725	2.147	41.453	2.229	99.555	5.269	53.71	3.52	24.48	1.0	0.67	36.3	1.5
	42.1	1.33	9.38696	0.06	50.948	2.365	108.064	5.631	127.824	3.882	76.82	4.86	22.66	0.8	0.66	34.1	1.2
	49.1	2.81	8.17399	0.04	52.887	2.394	36.902	1.980	105.822	3.718	61.80	3.88	24.52	0.9	0.72	34.0	1.3
DC2201	52.1	2.99	7.68191	0.02	4.126	0.248	9.717	0.651	135.596	4.458	6.60	0.51	212.94	9.3	0.73	292.9	12.8
	40.7	1.51	0.80598	0.03	5.098	0.519	9.328	0.832	107.754	2.861	7.45	0.86	20.07	1.6	0.66	30.4	2.4
	43.8	1.45	0.73778	0.02	4.327	0.263	10.567	0.868	143.804	3.007	7.01	0.56	19.51	1.1	0.68	28.9	1.6
	49.4	2.42	0.73591	0.02	4.100	0.318	8.522	0.570	129.787	2.913	6.28	0.57	21.72	1.2	0.76	28.8	1.7
	50.2	2.82	0.62425	0.01	3.693	0.219	10.562	0.634	129.714	4.137	6.36	0.47	18.20	0.8	0.74	24.5	1.1
MW2020	52.8	3.11	0.54056	0.01	2.873	0.249	6.077	0.409			4.32	0.40	23.22	1.56	0.76	30.51	2.05
	45.5	2.35	0.40438	0.01	1.607	0.187	2.744	0.248			2.26	0.28	33.17	3.04	0.75	44.17	4.05
	41.3	1.94	0.36298	0.01	1.630	0.209	2.057	0.451			2.12	0.35	31.73	3.70	0.69	46.19	5.39
	43.4	2.36	0.39565	0.01	2.074	0.277	3.563	0.341			2.92	0.41	25.11	2.56	0.72	34.73	3.54
	39.9	1.65	0.42660	0.02	2.171	0.400	4.										

Table B.4: QTQt modelling parameters used in this study.

Lab ID	Field ID	ZHe input [*]	AHe input [*]	AFT count input [*]	AFT length input [*]	General prior [†]	Upb T-t constraints [§]	reference [#]	other T-t constraints ^{**}	reference ^{††}	pre-burn-in	post-burn-in
160-1	VI2208	3	5		22	100±100 m.y., 150±150 °C	170±20 m.y., 850±50 °C	Nixon et al., 2011	166±20 m.y., 280±40 °C (KAr bt)	Han and Rukhlov, 2020	50000	100000
160-2	VI2211	2	5			80±80 m.y., 150±150 °C	171±20 m.y., 850±50 °C	Nixon et al., 2011			50000	100000
160-3	VI2206	3	5			80±80 m.y., 150±150 °C	183±20 m.y., 850±50 °C	Nixon et al., 2011			50000	100000
160-4	DC0640	3	5			90±90 m.y., 150±150 °C	177±20 m.y., 850±50 °C	Nixon et al., 2011	147±20 m.y., 530±40 °C (KAr hbl)	Han and Rukhlov, 2020	50000	100000
160-5	DC0645	3	5	33	102	100±100 m.y., 150±150 °C	165±20 m.y., 850±50 °C	Han and Rukhlov, 2020			50000	100000
160-6	DC0703	3	5			45±45 m.y., 150±150 °C	182±20 m.y., 850±50 °C ?	Han and Rukhlov, 2020	166±20 m.y., 280±40 °C (KAr bt)	Han and Rukhlov, 2020	50000	100000
160-7	DC2101		5	26	5	50±50 m.y., 70±70 °C	35±10 m.y., 850±50 °C	Madsen et al., 2006	36.5±10 m.y., 280±40 °C (KAr bt)	Han and Rukhlov, 2020	50000	100000
160-8	C510-93	3	5	32	102	70±70 m.y., 150±150 °C	41±15 m.y., 850±50 °C	Madsen et al., 2006	50±10 m.y., 280±40 °C (KAr bt)	Han and Rukhlov, 2020	50000	100000
160-9	JL06-78		5	31	15(cf)	75±75 m.y., 70±70 °C	175±20 m.y., 850±50 °C	Han and Rukhlov, 2020			50000	100000
160-13	DCMD04		5	33	109	45±45 m.y., 70±70 °C	181±20 m.y., 850±50 °C	Canil et al., 2013			50000	100000
160-14	DC2201	3	4			45±45 m.y., 150±150 °C	181±20 m.y., 850±50 °C	Canil et al., 2013			50000	100000
160-17	MW2020	4	5			70±70 m.y., 150±150 °C	197±20 m.y., 850±50 °C	Nixon et al., 2011	157±20 m.y., 530±40 °C (ArAr hbl)	Morris, 2023 (Thesis)	50000	100000
160-18	DC0661	5	4	21	98(cf)	75±75 m.y., 150±150 °C	180±20 m.y., 850±50°C	Canil et al., 2013			50000	100000
160-19	JL06-51	3	8	30	95(cf)	70±70 m.y., 150±150 °C	180±20 m.y., 850±50°C	Canil et al., 2013			50000	100000
160-21	VI2001	5	5	27	93(cf)	75±75 m.y., 150±150 °C	180±20 m.y., 850±50°C	Canil et al., 2013			50000	100000
FT95-045	93GPA-26-1			26	115	150±150 m.y., 70±70 °C	167±20 m.y., 850±50 °C	Nixon et al., 2011	168±20 m.y., 530±40 °C (ArAr hbl)	Nixon et al., 2011	50000	100000
FT95-046	93GNX-9-10			21	60	100±100 m.y., 70±70 °C	175±20 m.y., 850±50 °C	Nixon et al., 2011	165±20 m.y., 280±40 °C (KAr bt)	Nixon et al., 2011; Han and	50000	100000

Note: Modeling of all samples uses radiation damage model of Gautheron et al (2009) and fission track annealing model of Ketcham et al (2007). Dpar data is used as the compositional model, and etchant is 5.5 mol. Present-day temperature is assumed as 10 ± 10 °C.

*Number of single-grain input data including AFT, AHe, ZHe, FT length.

†Constraint box of general prior, encompassing all ZHe, AFT and AHe ages.

§A second constraint box is set according to the Upb ages of the bedrock in the study region.

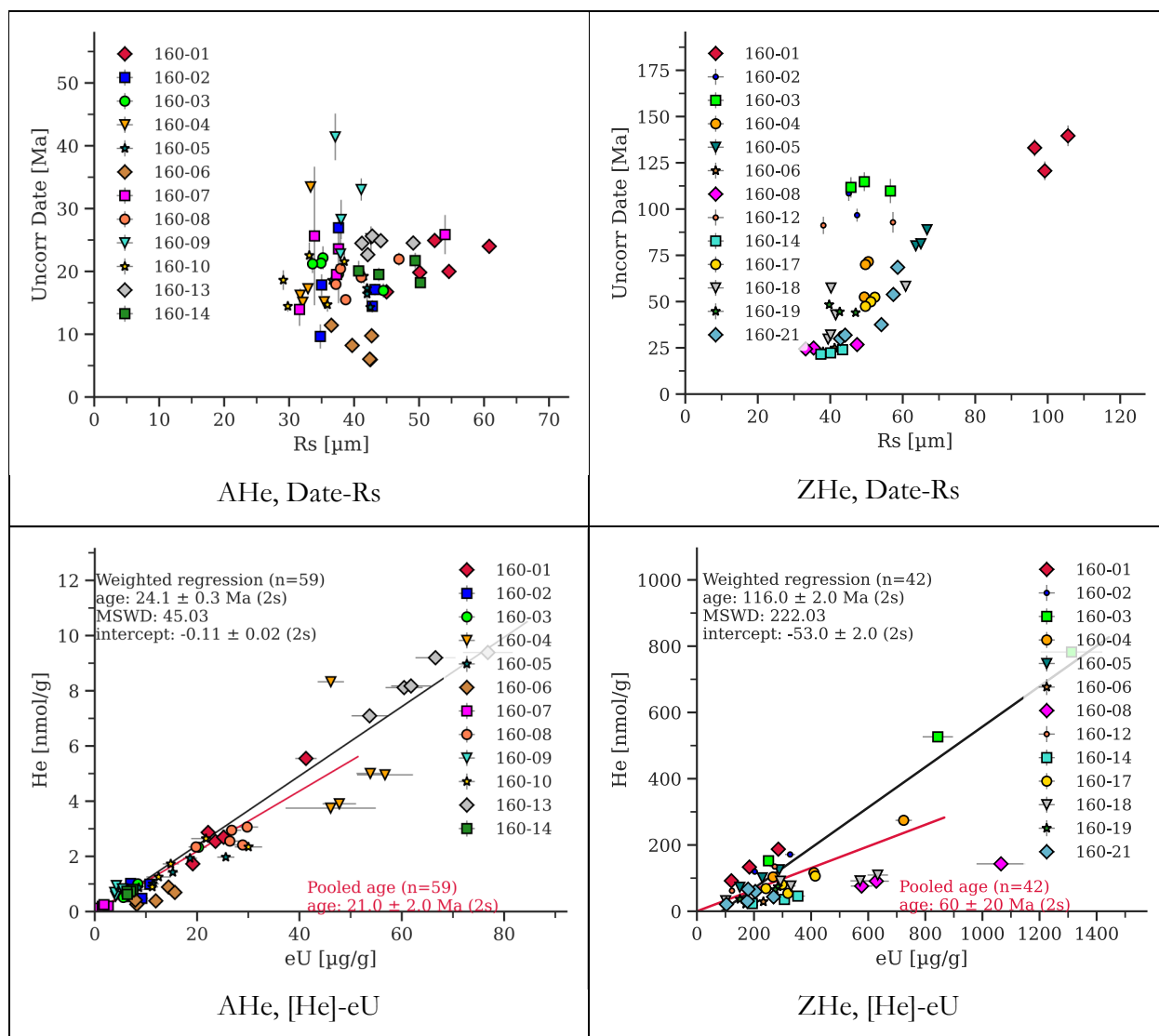
#Reference that provides the Upb constraint.

**A third constraint box is set according to the KAr or Ar-Ar ages of the bedrock in nearby region.

††Reference that provides the KAr or Ar-Ar constraint.

B.2 Appendix B Figures

Figure B.1: Plots of Rs - uncorrected date, [He] - eU and corrected date - eU for AHe and ZHe data of all samples. Rs - radius of a sphere with an equivalent alpha-ejection correction as the grain, calculated using Ketcham et al. (2011), [He] – corrected He content (daughter), eU – effective uranium concentration (parent).



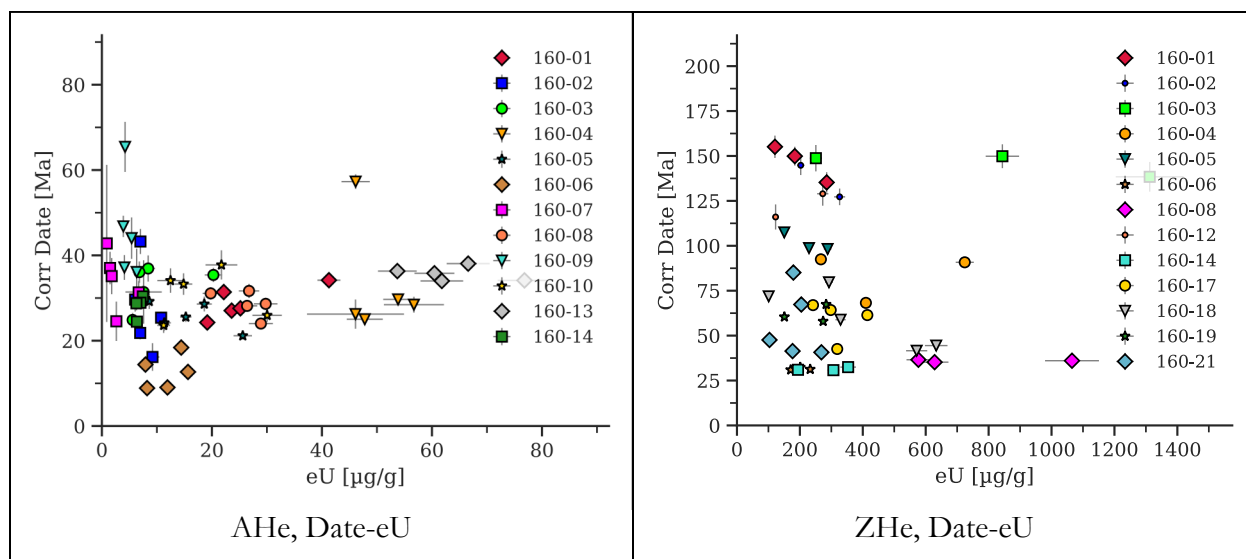
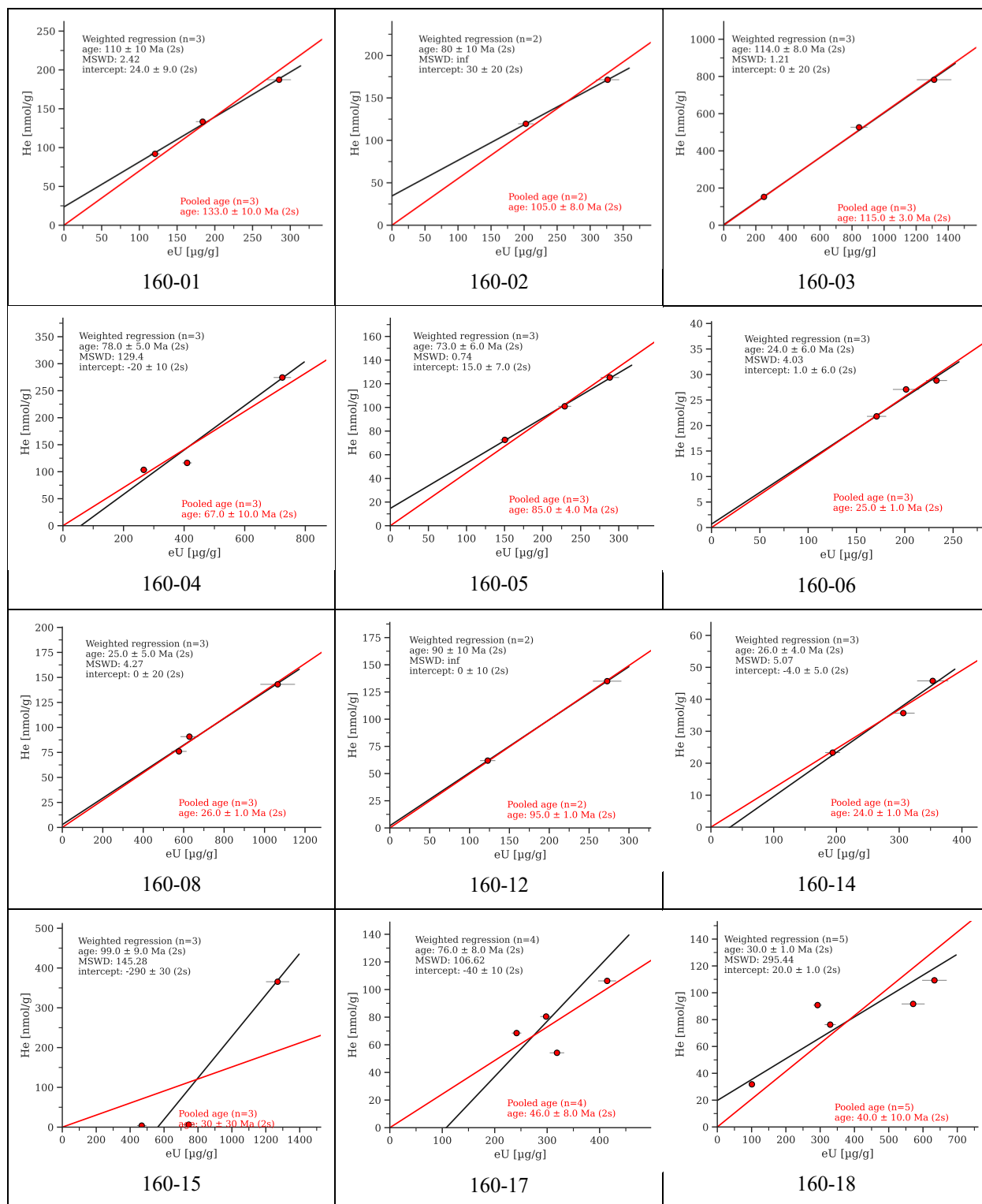


Figure B.2: [He] - eU plots for single-grain ZHe data. [He] – corrected He content (daughter), eU – effective uranium concentration (parent).



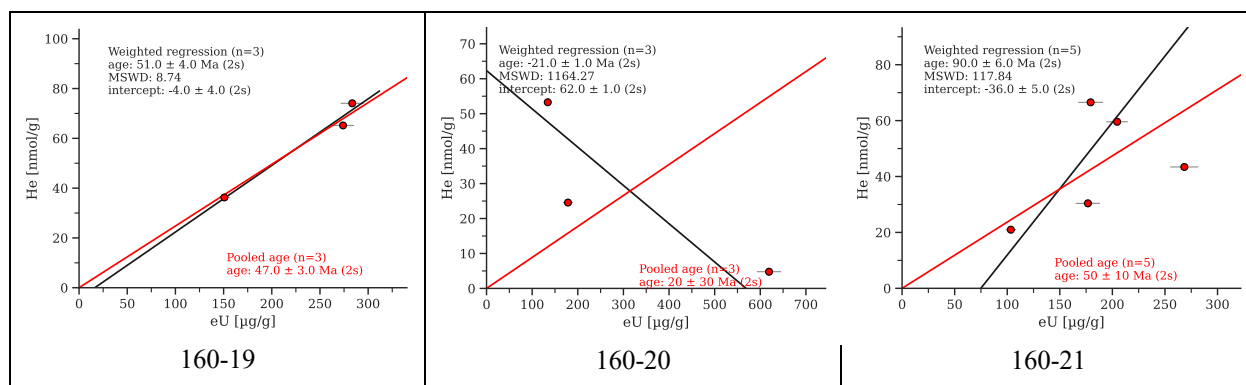
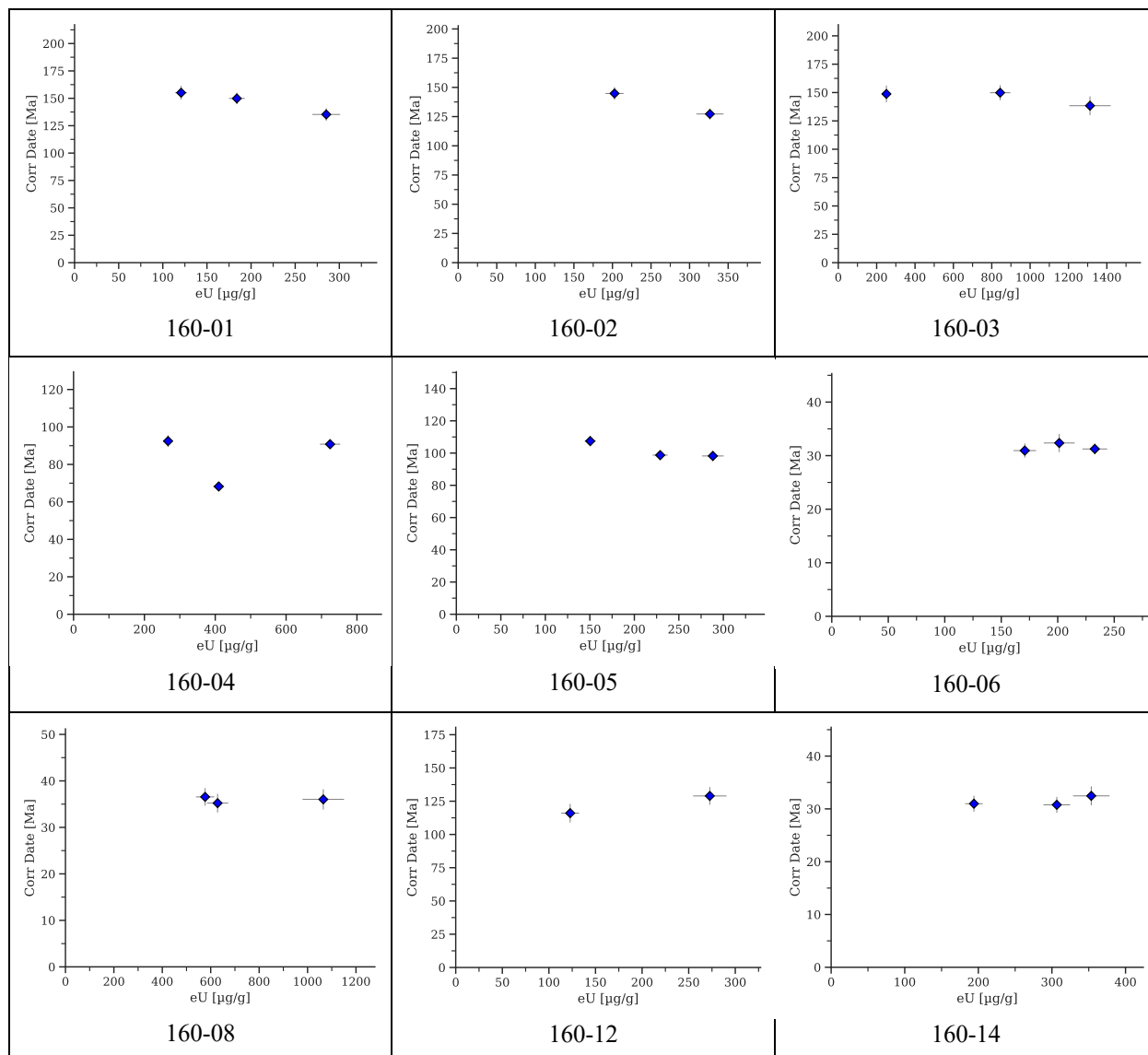


Figure B.3: Corrected date - eU plots for single-grain ZHe data. eU – effective uranium concentration (parent).



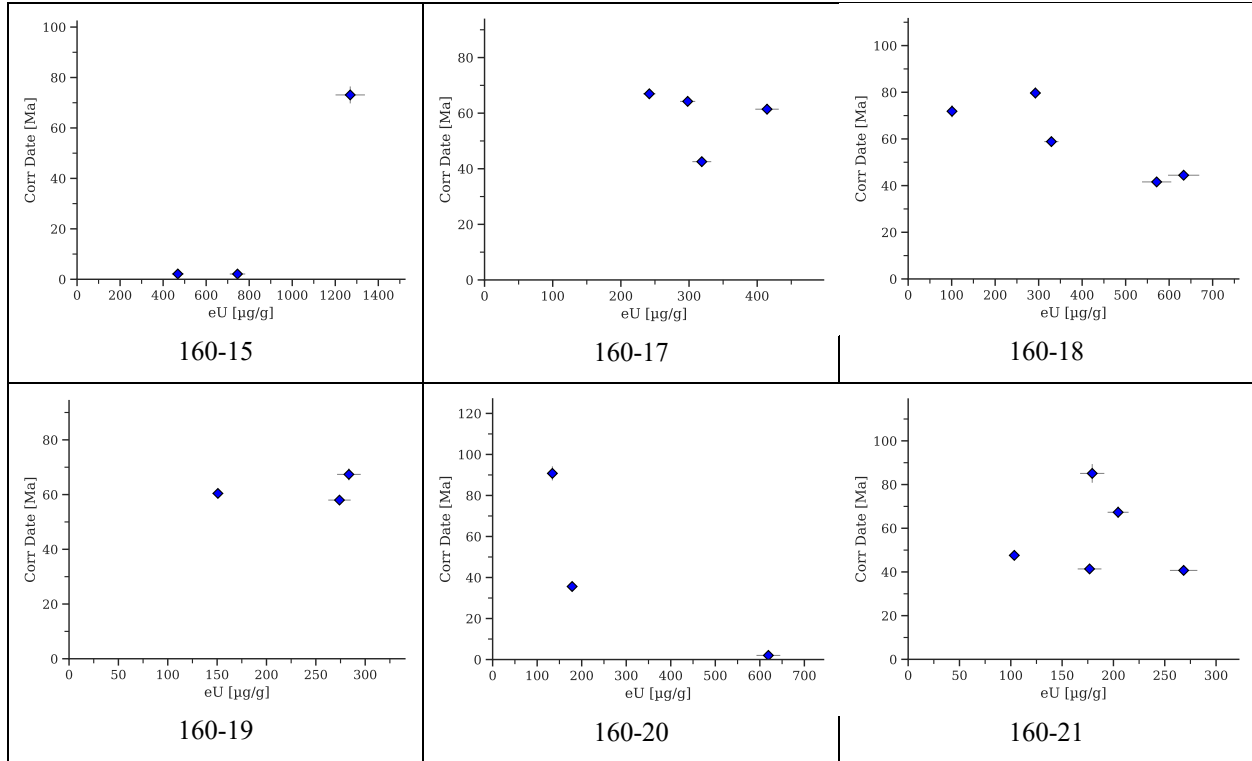
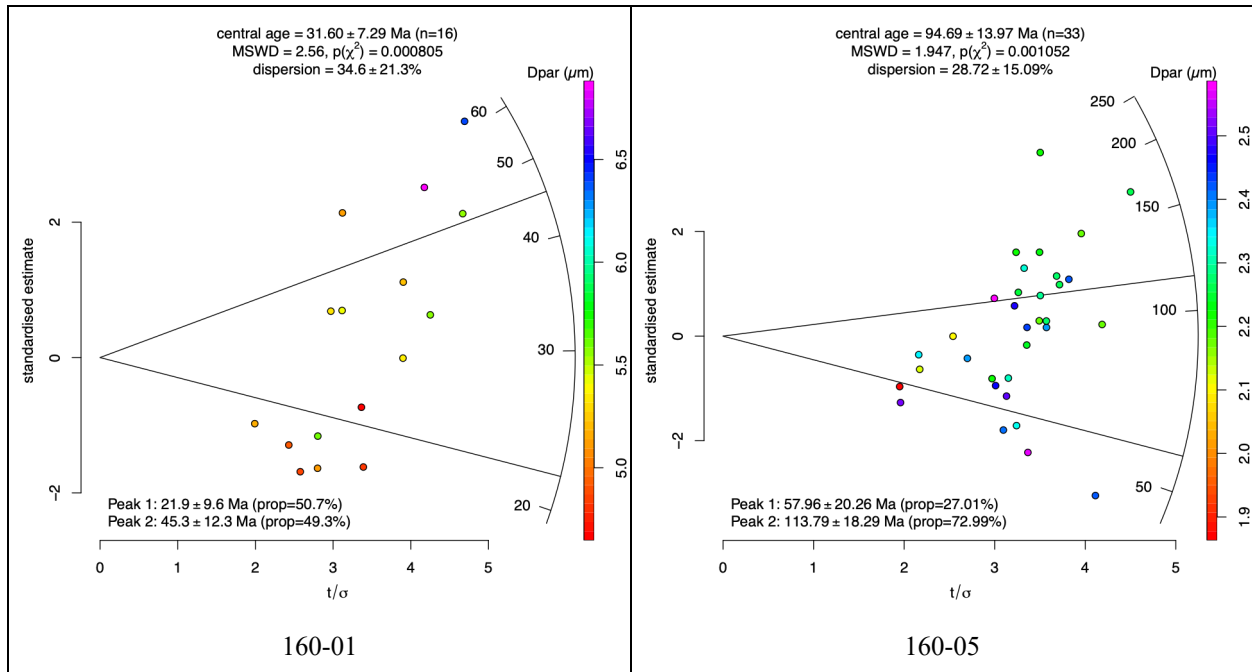


Figure B.4: Radial plots of single-grain AFT results for individual samples. MSWD - mean squared weighted deviation. $p(\chi^2)$ – probability density function of chi-square value to evaluate the scatter of age population. D_{par} : diameter of the track opening parallel to c-axis. Mixture mode was set “auto” when plotting.



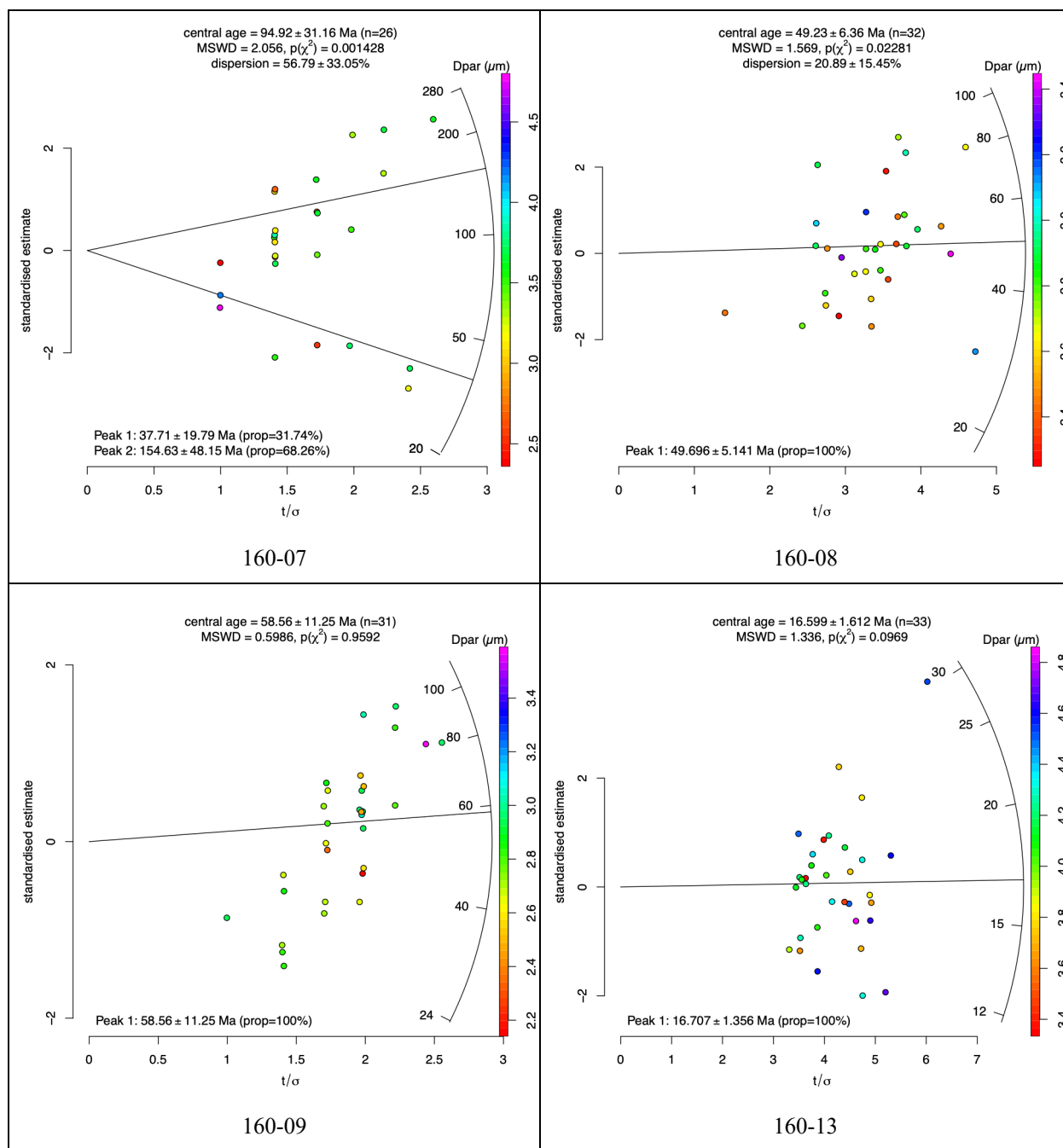


Figure B.5: Distribution histogram and probability density function (PDF) of confined track lengths for individual samples.

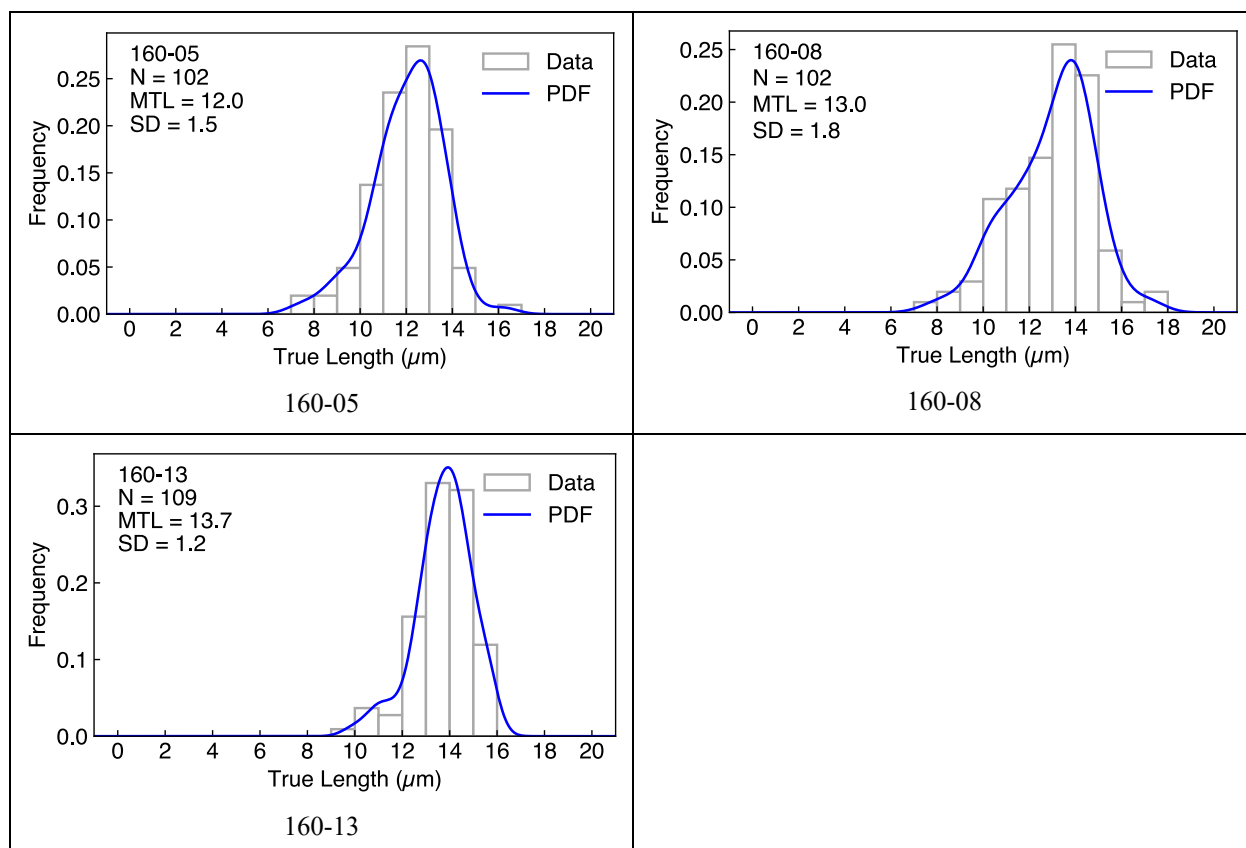


Figure B.6: [He] - eU plots for single-grain AHe data. [He] – corrected He content (daughter), eU – effective uranium concentration (parent).

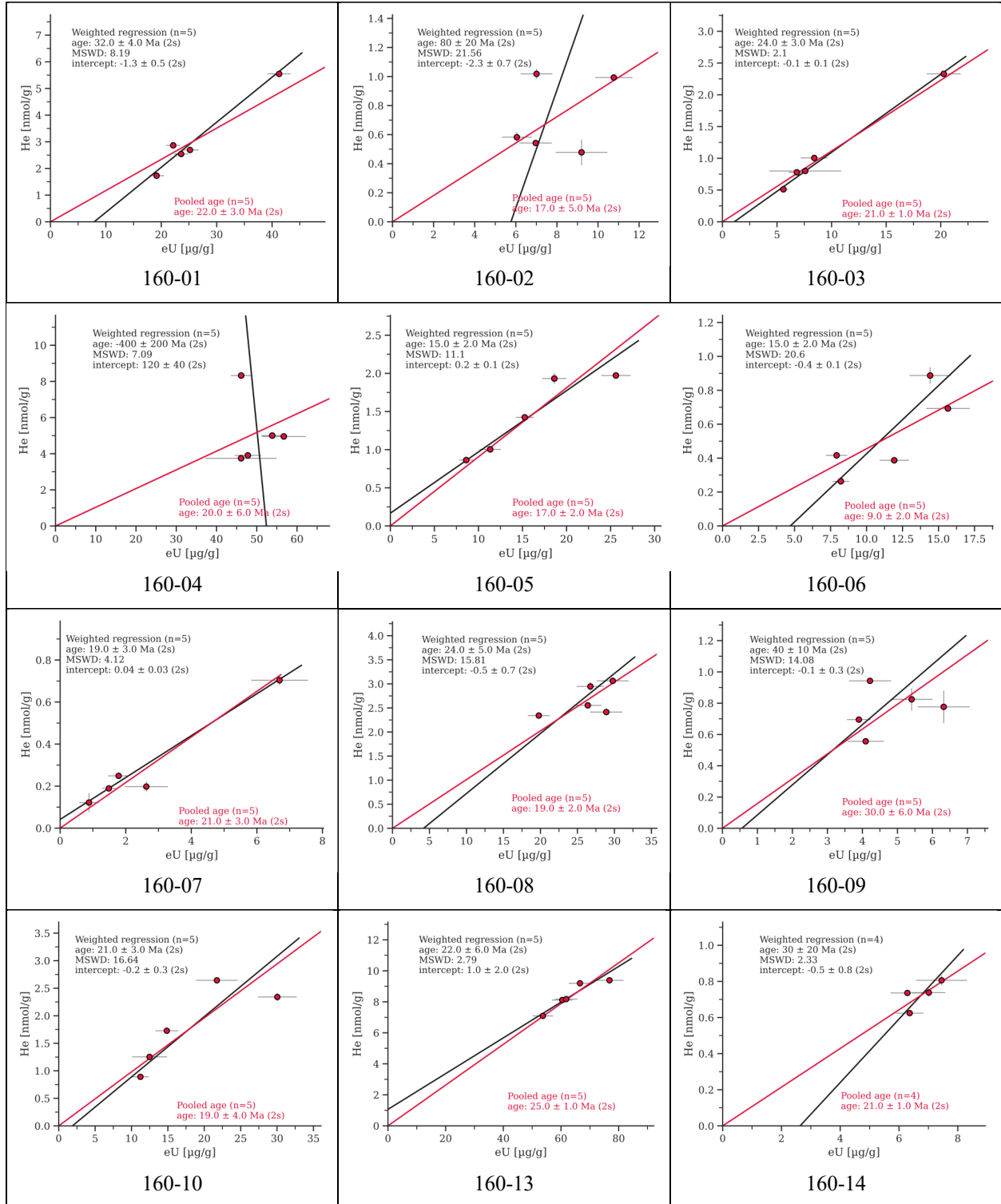


Figure B.7: Corrected date - eU plots for single-grain AHe data. eU – effective uranium concentration (parent).

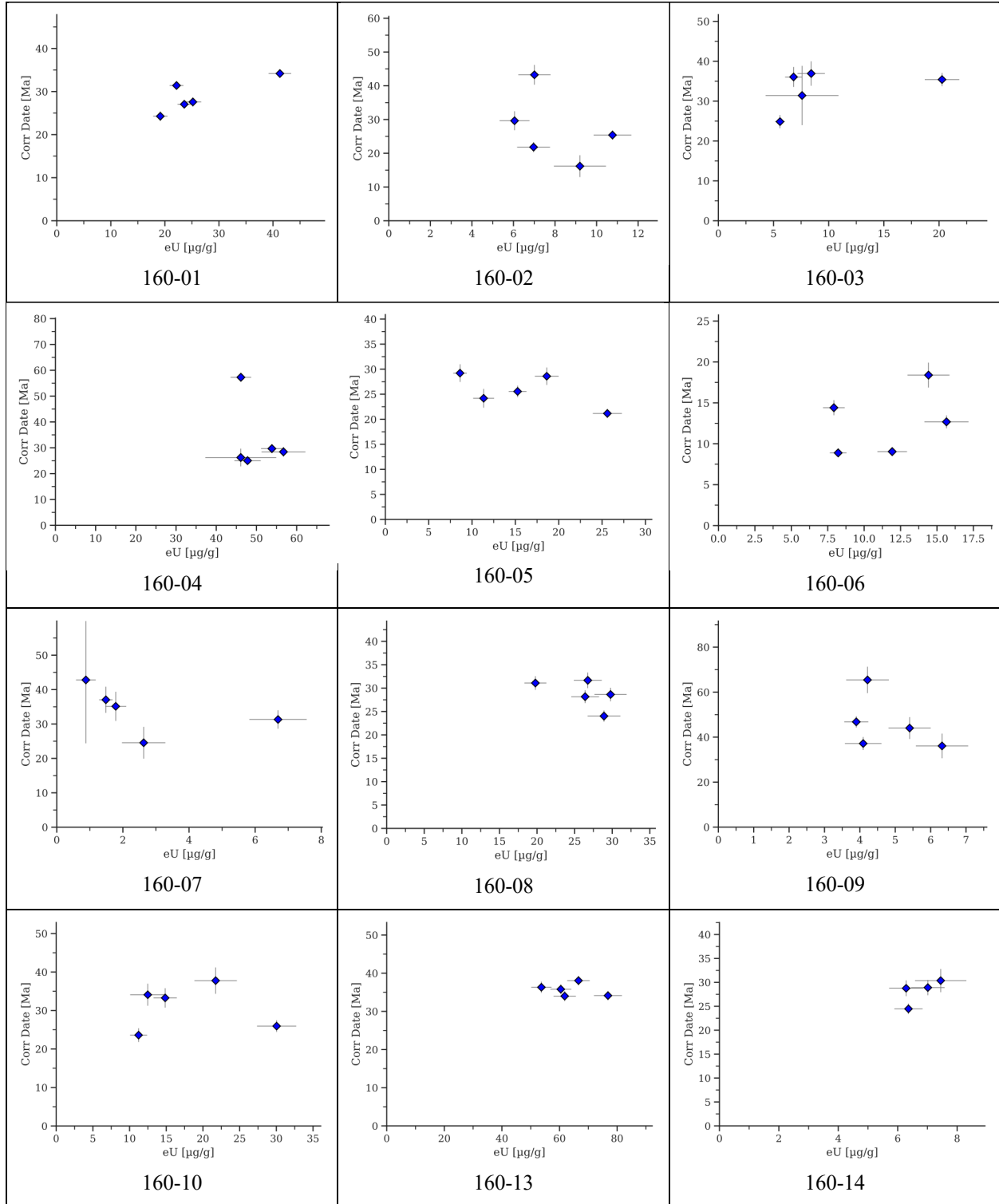
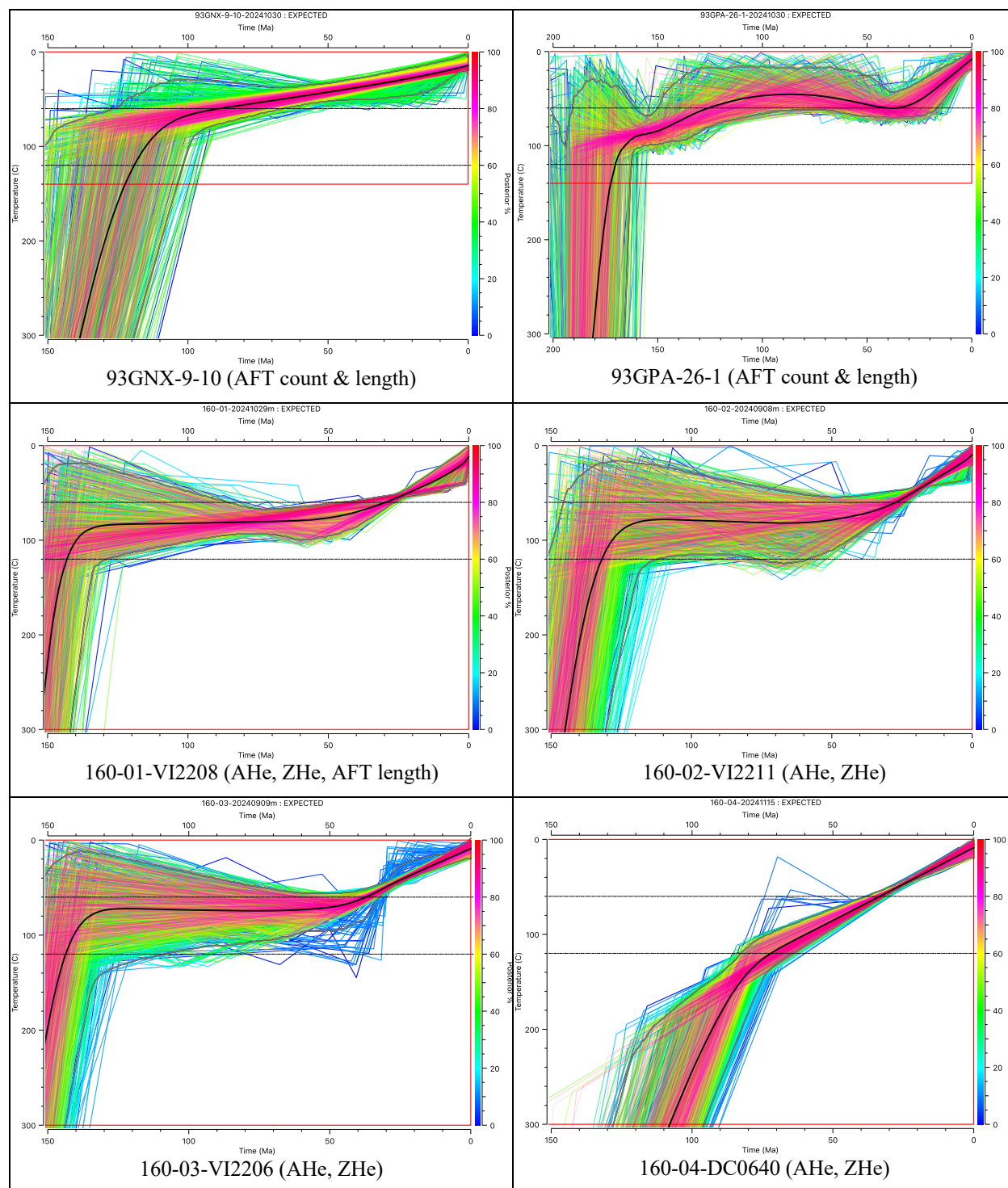
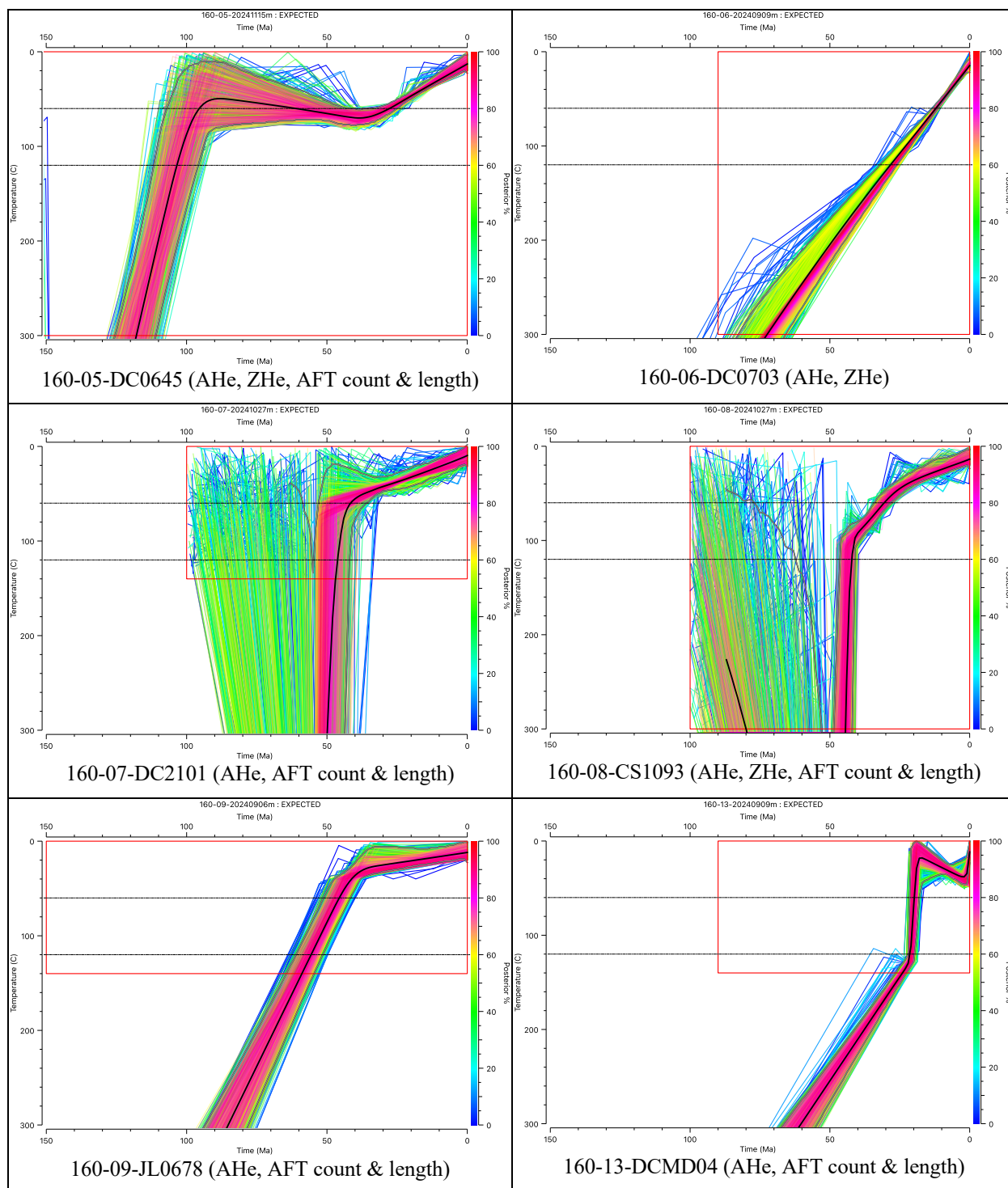
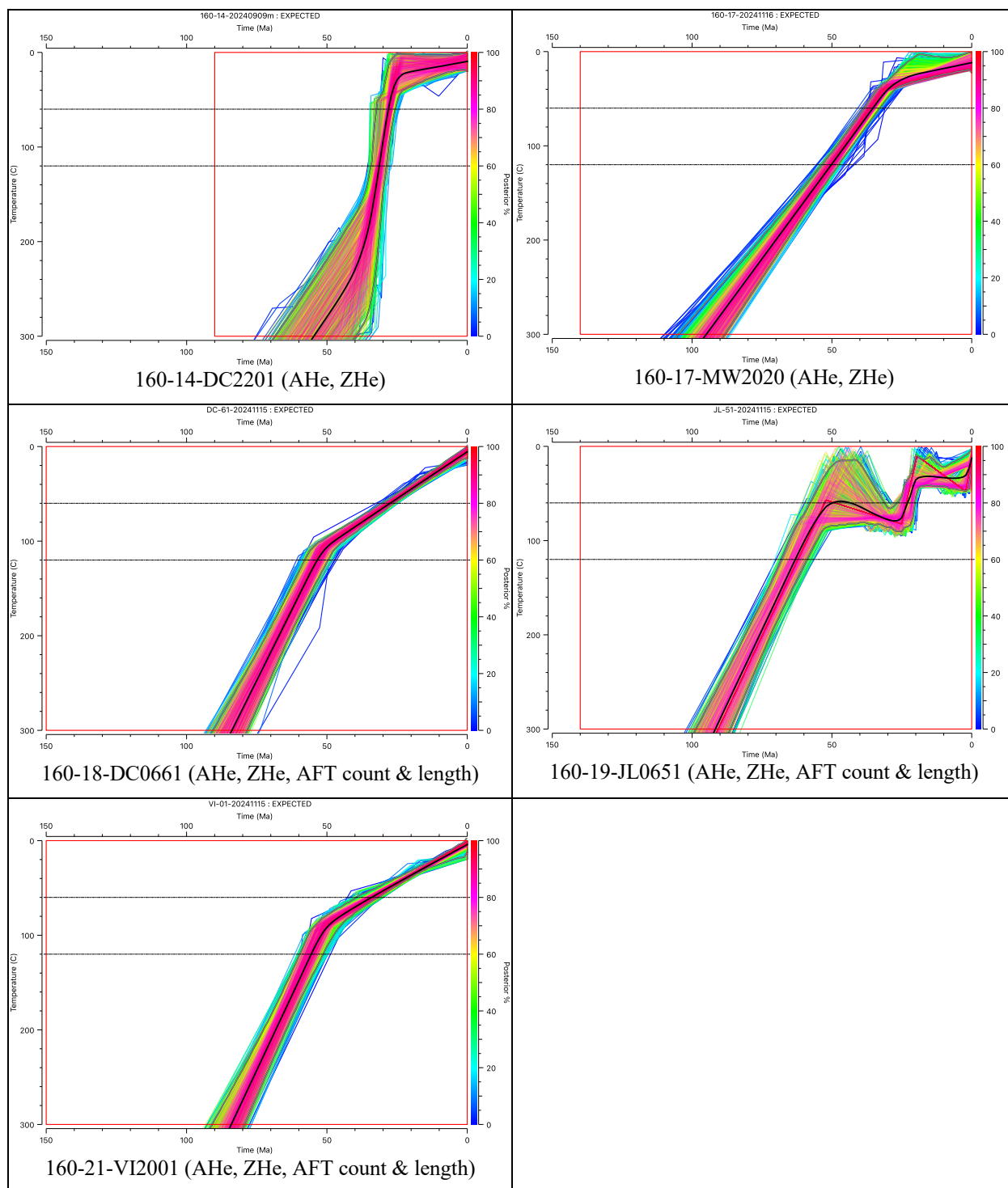


Figure B.8: Summary of QTQt outputs of time-temperature probability estimates for individual samples of Vancouver Island.

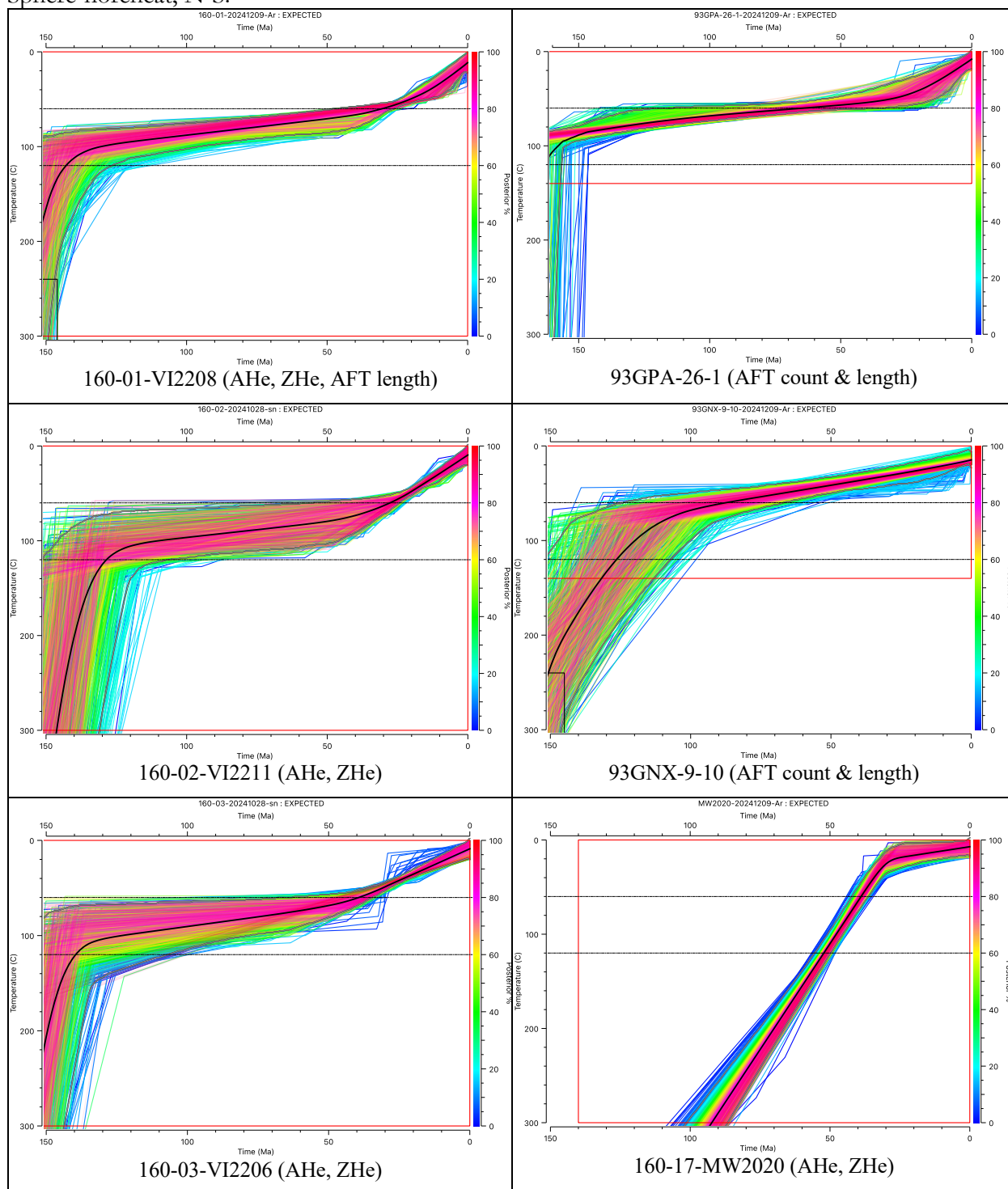
Original:

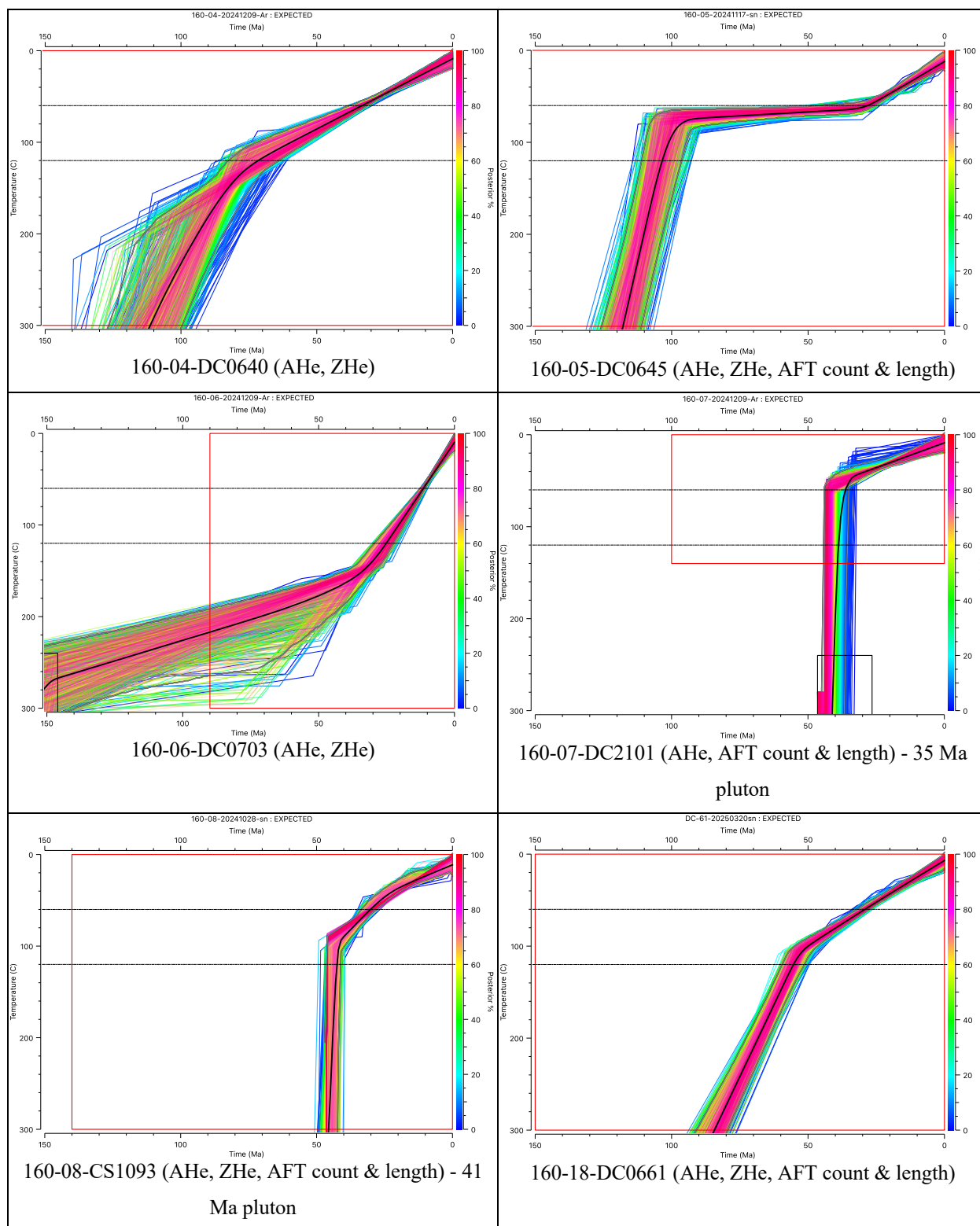


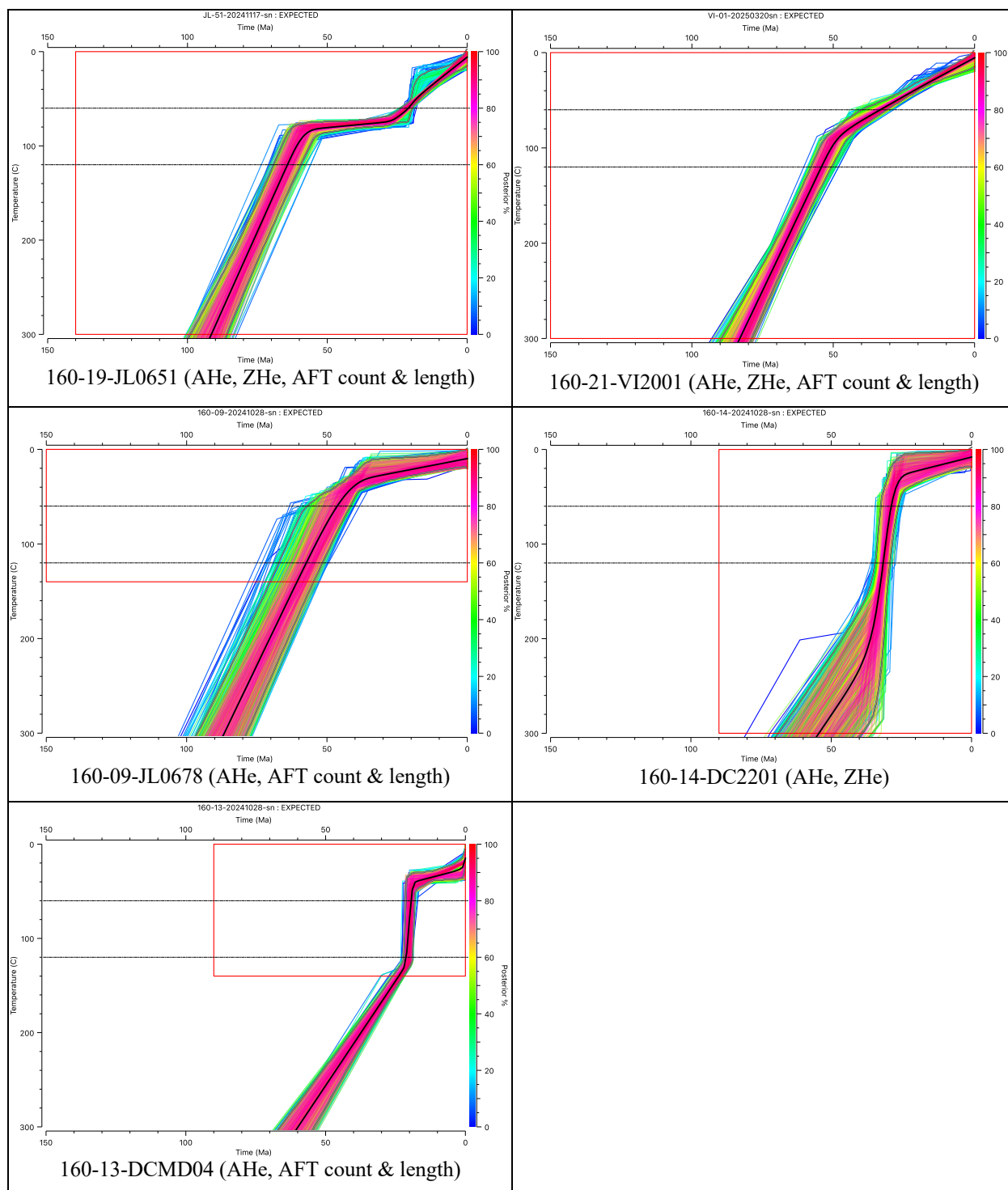




Sphere-noreheat, N-S:







Appendix C

Chapter 4 Supplemental Material

C.1 Appendix C Tables

Table C.1: Single grain Zircon Raman spot data. Values in grey font denote duplicate Raman data for the same analytical spot as noted above.

Spot	ω_1 ¹	ω_1 2SD ¹	Γ_1 ¹	Γ_1 2SD ¹	ω_2 ¹	ω_2 2SD ¹	Γ_2 ¹	Γ_2 2SD ¹	ω_3 ¹	ω_3 2SD ¹	Γ_3 ¹	Γ_3 2SD ¹	ω_R ¹	ω_R 2SD ¹	Γ_R ¹	Γ_R 2SD ¹
F16A2-01-m	969.90	0.73	9.91	1.48	439.26	0.15	14.19	0.61	1002.53	0.73	11.09	0.66	352.05	0.00	13.08	0.34
F16A2-01-p	969.35	0.00	9.98	0.24	439.00	0.72	14.23	0.39	1002.35	0.00	10.66	0.09	352.05	0.00	12.98	0.10
F16A2-02	968.48	0.59	10.63	0.50	438.56	0.00	15.25	1.09	1000.88	0.00	11.21	0.25	352.05	0.00	14.24	0.62
F16A2-03	966.64	1.28	13.42	0.56	438.20	0.85	16.80	1.21	999.60	1.40	14.91	1.73	348.90	1.28	18.77	1.79
F16A2-04	968.15	2.25	15.58	4.54	438.93	0.85	16.01	0.96	1001.06	2.50	16.01	5.28	350.77	1.40	16.74	2.77
F16A2-05	968.84	1.45	12.83	1.80	438.56	0.00	16.70	0.84	1003.23	1.66	33.95	18.34	351.87	0.73	14.61	1.87
F16A2-06	968.33	0.72	11.81	0.53	438.82	0.69	15.05	0.97	1001.06	0.73	13.87	1.12	350.26	0.77	16.53	1.25
F16A2-07					439.04	0.65	16.53	0.54					352.79	0.00	12.42	0.35
F16A2-08	967.40	0.85	12.99	0.14	438.53	1.08	16.35	2.21	1000.39	0.85	14.07	3.15	349.49	1.47	17.45	2.95
F16A2-09-l	968.38	2.24	12.72	1.09	438.93	0.85	17.02	1.50	1001.61	1.47	14.67	1.96	350.95	1.89	16.21	2.05
F16A2-10-l	970.82	0.00	12.00	5.46	438.93	0.85	14.63	0.93	1005.28	0.00	25.57	4.93	353.15	1.89	12.21	3.21
F16A2-11	969.17	3.25	11.47	4.53	438.31	0.69	15.11	6.77	1001.61	3.79	13.00	6.46	351.69	3.05	15.58	5.43
F16A2-13	967.89		16.22	0.00	438.82	0.69	14.79	1.33	1001.61		19.57	0.00	350.40	0.73	17.45	1.92
F16A2-14	969.54	1.40	13.57	1.64	438.67	0.44	16.11	1.61	1002.31	1.21	16.48	1.44	352.09	0.15	14.26	1.24
F16A2-15	969.17	1.40	10.59	1.77	437.83	0.00	15.53	1.71	1001.80	1.85	12.90	3.03	351.87	1.85	15.43	3.06
F16A2-16	969.72	1.47	10.61	3.32	438.56	0.00	15.00	1.97	1001.98	1.47	11.52	3.26	351.69	1.47	14.64	4.59
F16A2-17	967.16	0.00	12.83	0.95	437.90	0.29	16.49	1.71	999.96	0.73	14.97	1.60	349.38	0.69	18.04	1.40
F16A2-18					438.67	0.44	16.87	1.85					352.05	1.20	14.61	3.12
F16A2-19					439.30	0.00	14.83	1.33					352.69	1.50	13.02	2.20
F16A2-20-l					439.04	0.69	15.48	2.28					351.94	2.31	14.32	5.26
F16A2-21	970.45	1.89	9.13	3.07	438.27	1.04	13.34	2.72	1003.63	1.40	10.39	4.69	352.79	1.69	13.04	4.24
F16A2-22	968.33	1.68	15.21	7.90	439.37	0.17	15.84	3.20	1002.24	0.88	19.36	7.87	351.14	1.40	15.57	2.56
F16A2-23	968.55	0.29	11.45	2.29	438.56	0.00	15.59	0.59	1000.88	0.00	13.53	2.00	350.92	0.77	16.26	1.97
F16A2-24	967.71	0.73	13.23	3.54	438.71	0.59	17.07	3.57	1000.51	0.85	15.88	4.49	350.22	0.85	17.73	2.40
F16A2-25	969.79	2.11	11.22	5.33	439.08	0.70	16.78	1.52	1002.15	0.68	13.62	3.99	352.05	1.69	13.71	2.21
F16A2-26	967.01	0.79	15.91	1.89	438.56	0.00	14.25	0.29	1000.33	0.73	19.34	1.33	349.38	0.69	19.17	0.75
F16A2-27	970.01	0.29	9.96	1.66	439.99	0.15	12.81	0.55	1002.53	0.73	10.78	0.56	352.24	0.73	13.51	0.90
F16A2-28					439.54	3.39	52.83	116.26					350.34	2.24	19.32	10.61
F16A2-09-h		2.24	12.72	1.09	438.93	0.85	17.02	1.50	1001.61	1.47	14.67	1.96	350.95	1.89	16.21	2.05
F16A2-10-h		0.00	12.00	5.46	438.93	0.85	14.63	0.93	1005.28	0.00	25.57	4.93	353.15	1.89	12.21	3.21
F16A2-20-h					439.04	0.69	15.48	2.28					351.94	2.31	14.32	5.26
F16A2-28-h					439.54	3.39	52.83	116.26					350.34	2.24	19.32	10.61

¹ Raman band positions (ω) and bandwidths(Γ) are in cm⁻¹. Uncertainties with a non-zero value were determined from repeated 4-spot-set measurements.

² All isotope concentrations are in ppm.

³ Dose values are in 10¹⁶ α/g.

⁴ Single-grain date for different bands

Spot	Th232 (ppm)	Th232 2SD ²	U235 (ppm)	U235 2SD ²	U238 (ppm)	U238 2SD ²	D1 (10 ¹⁶ α/g) ³	D1 2SD ²	D2 (10 ¹⁶ α/g) ³	D2 2SD ²	D3 (10 ¹⁶ α/g) ³	D3 2SD ²	Der (10 ¹⁶ α/g) ³	Der 2SD ²	eU (ppm)	eU 2SD ²	Date1 (Ma) ⁴	Date2 (Ma) ⁴	Date3 (Ma) ⁴	DateR (Ma) ⁴
F16A2-01-m	489.77		147.29	2056.75	763.95	743.70	75.19	13.80	64.03	4.33	74.24	5.99	53.05	1.99	898.43	209.16	261.41	223.28	258.19	185.54
F16A2-01-p							75.90	2.22	64.33	2.75	70.33	0.81	52.46	0.58	0.00	0.00				
F16A2-02	869.75	272.83	2819.96	1264.06	957.00	297.97	81.94	4.68	71.59	7.70	75.31	2.27	59.81	3.61	1213.59	319.64	211.72	185.36	194.85	155.22
F16A2-03	810.42	174.18	2926.20	945.28	1035.23	246.96	108.03	5.26	82.54	8.55	108.69	15.59	86.32	10.46	1281.49	262.66	263.31	202.13	264.67	211.23
F16A2-04	1112.74	255.04	3316.30	1425.05	1191.46	388.63	128.19	42.38	76.97	6.84	118.56	47.54	74.45	16.21	1518.09	412.63	263.72	159.65	244.28	154.48
F16A2-05	443.62	227.11	2221.95	1274.90	779.15	364.42	102.47	16.85	81.85	5.93	280.14	165.19	61.97	10.94	924.58	386.51	343.98	276.21	900.11	210.21
F16A2-06	468.80	152.01	1989.88	727.94	694.89	177.50	92.99	4.94	70.11	6.91	99.28	10.09	73.21	7.31	842.15	189.92	342.76	260.09	365.30	271.36
F16A2-07	264.93	66.01	1666.63	607.75	598.94	150.04			80.60	3.86			49.21	2.02	692.48	158.34		360.79		222.65
F16A2-08	679.90	318.84	2748.45	1438.28	966.06	392.27	103.97	1.35	79.34	15.68	101.04	28.40	78.58	17.26	1177.54	418.93	275.51	211.29	267.90	209.31
F16A2-09-l	475.12	322.49	2045.83	1125.40	721.92	356.29	101.43	10.19	84.11	10.61	106.48	17.65	71.35	11.97	872.05	382.03	360.52	300.38	377.97	255.71
F16A2-10-l	617.91	218.61	1562.49	633.83	525.01	147.71	94.70	51.05	67.18	6.58	204.71	44.38	47.93	18.75	699.56	163.73	417.74	299.11	671.32	214.79
F16A2-11	589.94	124.10	2412.42	680.70	863.20	204.51	89.80	42.33	70.55	47.98	91.46	58.21	67.67	31.74	1047.95	216.79	267.56	211.12	272.41	202.64
F16A2-13	732.04	265.03	2637.13	1071.04	915.35	345.26	134.15	0.00	68.32	9.44	150.65	0.00	78.59	11.21	1136.81	368.06	365.64	188.81	409.19	216.71
F16A2-14	837.41	267.80	2806.94	1021.40	965.17	251.85	109.43	15.33	77.65	11.45	122.83	12.96	59.96	7.25	1214.40	272.14	281.06	200.68	314.65	155.52
F16A2-15	803.95	237.68	2761.70	1237.32	945.01	367.14	81.54	16.53	73.55	12.11	90.50	27.26	66.81	17.92	1185.21	389.69	215.67	194.85	238.94	177.25
F16A2-16	1365.00	479.52	3489.62	1804.68	1196.42	505.41	81.72	31.00	69.81	13.95	78.14	29.35	62.15	26.86	1583.84	543.02	162.43	139.00	155.40	123.89
F16A2-17	774.83	224.18	2889.96	1233.95	991.33	394.59	102.48	8.86	80.39	12.13	109.21	14.39	82.03	8.19	1228.85	355.42	260.94	205.57	277.72	209.70
F16A2-18	1606.96	619.59	4079.63	1923.09	1410.44	439.57			83.07	13.10			62.01	18.25	1866.63	484.91		140.34		105.05
F16A2-19	497.36	120.79	1483.62	744.08	543.38	146.56			68.61	9.47			52.66	12.84	689.91	158.66		309.47		238.86
F16A2-20-l	506.59	131.96	1593.36	739.94	567.59	149.63			73.17	16.16			60.30	30.78	717.55	160.27		317.14		262.48
F16A2-21	328.21	89.97	1576.85	841.88	575.87	170.11	67.95	28.65	57.99	19.31	67.89	42.26	52.81	24.81	683.44	179.92	309.41	264.96	309.16	241.75
F16A2-22	240.75	68.04	1424.52	620.74	517.40	158.06	124.75	73.85	75.71	22.70	148.77	70.91	67.60	14.99	601.05	166.76	629.89	389.58	744.40	348.93
F16A2-23	586.88	149.41	2463.53	904.80	884.53	230.81	89.60	21.39	73.96	4.16	96.18	18.01	71.61	11.50	1069.61	244.98	261.66	216.76	280.48	206.98
F16A2-24	824.36	209.00	2738.51	1049.39	992.46	338.54	106.19	33.06	84.49	25.34	117.39	40.49	80.21	14.04	1239.93	358.78	267.41	213.65	294.97	203.00
F16A2-25	313.42	141.49	1637.21	779.87	606.22	222.19	87.49	49.81	82.44	10.81	96.98	35.98	56.70	12.95	711.76	235.76	380.40	359.05	420.39	249.10
F16A2-26	972.76	384.99	2521.81	1088.94	938.47	299.71	131.23	17.67	64.46	2.04	148.55	12.02	88.64	4.38	1218.86	327.98	334.40	166.44	377.28	227.76
F16A2-27	1150.86	328.03	2843.00	1247.60	1050.68	407.49	75.62	15.51	54.22	3.90	71.47	5.08	55.55	5.27	1379.42	435.05	172.44	124.11	163.05	158.58
F16A2-28	1590.95	537.17	3126.18	1162.96	1144.82	332.71			338.06	824.56			89.51	62.05	1589.14	372.37		644.84		177.11
F16A2-09-h	1219.40	499.12	4196.68	2217.77	1556.22	751.53	101.43	10.19	84.11	10.61	106.48	17.65	71.35	11.97	872.05	382.03	156.67	137.69	173.82	117.10
F16A2-10-h	1326.49	392.02	2405.92	904.45	844.31	251.62			94.70	51.05			47.93	18.75	1204.88	280.43	245.82	175.35	520.10	125.59
F16A2-11-h	192.87	49.43	1499.43	683.43	363.43	149.63			73.17	16.16			60.30	30.78	717.55	160.27		317.14		262.48
F16A2-09-b	1606.96	892.22	3522.36	1559.51	1325.41	599.60			378.06	824.56			89.51	62.05	1772.26	579.93	0.00	579.59	0.00	158.58

Spot	ω_1^1	$\omega_1 2SD^1$	r_1^1	$r_1 2SD^1$	ω_2^1	$\omega_2 2SD^1$	r_2^1	$r_2 2SD^1$	ω_3^1	$\omega_3 2SD^1$	r_3^1	$r_3 2SD^1$	ω_R^1	$\omega_R 2SD^1$	r_R^1	$r_R 2SD^1$
V12208-01-low	973.31	0.00	3.71	0.22	438.42	0.00	8.30	0.40	1006.28	0.47	4.19	0.17	354.74	0.00	6.39	0.07
V12208-02-low	972.53	0.00	3.86	0.08	439.20	0.00	9.53	0.08	1006.51	0.82	5.30	0.36	354.27	0.68	7.39	0.09
V12208-03-low	973.31	0.00	3.56	0.12	438.42	0.00	7.81	0.65	1006.94	0.00	4.05	0.15	355.01	0.69	6.14	0.29
V12208-04-low	973.31	0.00	3.41	0.14	438.42	0.00	7.53	0.13	1006.94	0.00	4.26	0.14	355.52	0.00	5.64	0.07
V12208-05-low	973.31	0.00	3.78	0.11	439.20	0.00	7.41	0.09	1006.94	0.00	3.85	0.03	355.52	0.00	5.93	0.01
V12208-06-low	973.31	0.00	3.87	0.41	439.20	0.00	9.15	0.75	1006.16	0.00	4.76	0.59	354.35	0.90	7.67	0.56
V12208-07-low	973.31	0.00	3.51	0.05	439.20	0.00	8.80	0.12	1006.94	0.00	4.09	0.06	355.52	0.00	6.13	0.06
V12208-08-low					438.42	0.00	7.52	0.48					355.52	0.00	5.90	0.18
V12208-09-low	973.31	0.00	3.76	0.12	439.20	0.00	8.17	0.23	1006.78	0.63	4.50	0.18	354.74	0.00	7.18	0.10
V12208-10-low					439.20	0.00	10.74	0.35	1006.94	0.00	7.96	1.86	355.05	0.77	6.64	0.14
V12208-11	973.31	0.00	3.78	0.14	439.20	0.00	8.50	0.11	1006.94	0.00	4.76	0.12	354.74	0.00	7.25	0.10
V12208-12-low					439.20	0.00	10.01	0.09	1006.94	0.00	5.23	0.08	354.74	0.00	6.71	0.11
V12208-13-low	973.31	0.00	3.55	0.15	439.20	0.00	8.21	0.06	1006.94	0.00	4.30	0.13	354.74	0.00	6.71	0.08
V12208-14-low	973.31	0.00	3.11	0.50	439.20	0.00	8.55	0.09	1006.94	0.00	6.10	0.14	355.52	0.00	5.76	0.03
V12208-15-low					439.20	0.00	10.83	0.17					354.74	0.00	7.29	0.10
V12208-16-low	973.31	0.00	3.66	0.10	439.20	0.00	10.34	0.16	1006.94	0.00	4.67	0.03	354.74	0.00	6.74	0.09
V12208-17-low	972.69	0.63	3.96	0.13	439.20	0.00	9.75	0.12	1006.16	0.00	5.56	0.06	353.96	0.00	8.34	0.16
V12208-18-low					439.20	0.00	9.87	0.16	1006.94	0.00	7.41	0.20	354.74	0.00	6.67	0.11
V12208-19-low					439.20	0.00	10.81	0.16	1006.16	0.00	9.42	0.31	354.74	0.00	7.21	0.07
V12208-20-low	973.31	0.00	3.65	0.07	438.73	0.77	7.56	0.78	1006.94	0.00	4.42	0.08	354.74	0.00	6.52	0.04
V12208-21-low	972.53	0.00	4.15	0.28	439.98	0.00	12.56	0.13	1006.94	0.00	10.37	0.27	354.74	0.00	7.52	0.08
V12208-22-low	973.16	0.63	4.01	0.20	439.20	0.00	9.72	0.22	1006.16	0.00	5.63	0.10	353.96	0.00	8.28	0.20
V12208-23-low	973.31	0.00	3.57	0.07	439.20	0.00	7.66	0.14	1006.94	0.00	3.92	0.05	355.52	0.00	5.69	0.04
V12208-24-low	973.31	0.00	3.57	0.15	439.20	0.00	9.07	0.29	1006.94	0.00	4.54	0.09	355.52	0.00	6.40	0.05
V12208-25-low					439.20	0.00	9.82	0.18					355.52	0.00	6.58	0.14
V12208-26-core-low	973.31	0.00	3.73	0.13	439.67	0.77	10.78	0.19	1006.94	0.00	4.90	0.11	354.74	0.00	6.79	0.09
V12208-26-rim-low	973.31	0.00	3.38	0.04	439.20	0.00	7.84	0.11	1006.94	0.00	3.79	0.07	355.52	0.00	5.72	0.05
V12208-27-low	973.31	0.00	3.97	0.25	439.20	0.00	10.55	0.10	1006.94	0.00	5.94	1.13	354.74	0.00	7.78	0.09
V12208-28-low	972.53	0.00	4.12	0.16	439.20	0.00	10.44	0.28	1006.16	0.00	6.14	0.18	352.39	0.00	9.13	0.43
V12208-29-low	973.31	0.00	3.43	0.11	438.42	0.00	6.94	0.03	1006.94	0.00	3.64	0.08	355.52	0.00	5.76	0.18
V12208-30-core-low					439.20	0.00	10.77	0.52	1006.94	0.00	5.72	0.12	354.74	0.00	6.98	0.16
V12208-30-rim-low	973.31	0.00	2.97	0.13	439.04	0.63	7.65	0.25	1006.94	0.00	3.52	0.09	355.52	0.00	5.53	0.14
V12208-31					439.98	0.00	12.67	0.93					353.96	0.00	8.25	0.36
V12208-32-low					439.20	0.00	10.66	0.14	1006.94	0.00	11.61	0.91	354.74	0.00	7.21	0.10
V12208-01-high	973.31	0.00	3.71	0.22	438.42	0.00	8.30	0.40	1006.28	0.47	4.19	0.17	354.74	0.00	6.39	0.07
V12208-02-high	972.53	0.00	3.86	0.08	439.20	0.00	9.53	0.08	1006.51	0.82	5.30	0.36	354.27	0.68	7.39	0.09
V12208-03-high	973.31	0.00	3.56	0.12	438.42	0.00	7.81	0.65	1006.94	0.00	4.05	0.15	355.01	0.69	6.14	0.29
V12208-04-high	973.31	0.00	3.41	0.14	438.42	0.00	7.53	0.13	1006.94	0.00	4.26	0.14	355.52	0.00	5.64	0.07
V12208-05-high	973.31	0.00	3.78	0.11	439.20	0.00	7.41	0.09	1006.94	0.00	3.85	0.03	355.52	0.00	5.93	0.01
V12208-06-high	973.31	0.00	3.87	0.41	439.20	0.00	9.15	0.75	1006.16	0.00	4.76	0.59	354.35	0.90	7.67	0.56
V12208-07-high	973.31	0.00	3.51	0.05	439.20	0.00	8.80	0.12	1006.94	0.00	4.09	0.06	355.52	0.00	6.13	0.06
V12208-08-high					438.42	0.00	7.52	0.48					355.52	0.00	5.90	0.18
V12208-09-high	973.31	0.00	3.76	0.12	439.20	0.00	8.17	0.23	1006.78	0.63	4.50	0.18	354.74	0.00	7.18	0.10
V12208-10-high					439.20	0.00	10.74	0.35	1006.94	0.00	7.96	1.86	355.05	0.77	6.64	0.14
V12208-11	973.31	0.00	3.78	0.14	439.20	0.00	8.50	0.11	1006.94	0.00	4.76	0.12	354.74	0.00	7.25	0.10
V12208-12-high					439.20	0.00	10.01	0.09	1006.94	0.00	5.23	0.08	354.74	0.00	6.71	0.11
V12208-13-high	973.31	0.00	3.55	0.15	439.20	0.00	8.21	0.06	1006.94	0.00	4.30	0.13	354.74	0.00	6.71	0.08
V12208-14-high	973.31	0.00	3.11	0.50	439.20	0.00	8.55	0.09	1006.94	0.00	6.10	0.14	355.52	0.00	5.76	0.03
V12208-15-high					439.20	0.00	10.83	0.17					354.74	0.00	7.29	0.10
V12208-16-high	973.31	0.00	3.66	0.10	439.20	0.00	10.34	0.16	1006.94	0.00	4.67	0.03	354.74	0.00	6.74	0.09
V12208-17-high	972.69	0.63	3.96	0.13	439.20	0.00	9.75	0.12	1006.16	0.00	5.56	0.06	353.96	0.00	8.34	0.16
V12208-18-high					439.20	0.00	9.87	0.16	1006.94	0.00	7.41	0.20	354.74	0.00	6.67	0.11
V12208-19-high					439.20	0.00	10.81	0.16	1006.16	0.00	9.42	0.31	354.74	0.00	7.21	0.07
V12208-20-high	973.31	0.00	3.65	0.07	438.73	0.77	7.56	0.78	1006.94	0.00	4.42	0.08	354.74	0.00	6.52	0.04
V12208-21-high	972.53	0.00	4.15	0.28	439.98	0.00	12.56	0.13	1006.94	0.00	10.37	0.27	354.74	0.00	7.52	0.08
V12208-22-high	973.16	0.63	4.01	0.20	439.20	0.00	9.72	0.22	1006.16	0.00	5.63	0.10	353.96	0.00	8.28	0.20
V12208-23-high	973.31	0.00	3.57	0.07	439.20	0.00	7.66	0.14	1006.94	0.00	3.92	0.05	355.52	0.00	5.69	0.04
V12208-24-high	973.31	0.00	3.57	0.15	439.20	0.00	9.07	0.29	1006.94	0.00	4.54	0.09	355.52	0.00	6.40	0.05
V12208-25-high					439.20	0.00	9.82	0.18					355.52	0.00	6.58	0.14
V12208-26-core-hi	973.31	0.00	3.73	0.13	439.67	0.77	10.78	0.19	1006.94	0.00	4.90	0.11	354.74	0.00	6.79	0.09
V12208-26-rim-hig	973.31	0.00	3.38	0.04	439.20	0.00	7.84	0.11	1006.94	0.00	3.79	0.07	355.52	0.00	5.72	0.05
V12208-27-high	973.31	0.00	3.97	0.25	439.20	0.00	10.55	0.10	1006.94	0.00	5.94	1.13	354.74	0.00	7.78	0.09
V12208-28-high	972.53	0.00	4.12	0.16	439.20	0.00	10.44	0.28	1006.16	0.00	6.14	0.18	352.39	0.00	9.13	0.43
V12208-29-high	973.31	0.00	3.43	0.11	438.42	0.00	6.94	0.03	1006.94	0.00	3.64	0.08	355.52	0.00	5.76	0.18
V12208-30-core-high					439.20	0.00	10.77	0.52	1006.94	0.00	5.72	0.12	354.74	0.00	6.98	0.16
V12208-30-rim-hig	973.31	0.00	2.97	0.13	439.04	0.63	7.65	0.25	1006.94	0.00	3.52	0.09	355.52	0.00	5.53	0.14
V12208-31					439.98	0.00	12.67	0.93					353.96	0.00	8.25	0.36
V12208-32-high					439.20	0.00	10.66	0.14	1006.94	0.00	11.61	0.91	354.74	0.00	7.21	0.10

Spot	Th232 (ppm)	Th232 2SD ²	U235 (ppm)	U235 2SD ²	U238 (ppm)	U238 2SD ²	D1 (10 ¹⁶ α/g) ³	D1 2SD ³	D2 (10 ¹⁶ α/g) ³	D2 2SD ³	D3 (10 ¹⁶ α/g) ³	D3 2SD ³	Der (10 ¹⁶ α/g) ³	Der 2SD ³	eU (ppm)	eU 2SD ²	Date1 (Ma) ⁴	Date2 (Ma) ⁴	Date3 (Ma) ⁴	DateER (Ma) ⁴
VI2208-01-low	49.37	13.68	227.51	208.27	87.37	23.26	17.28	2.06	22.24	2.83	12.03	1.53	13.91	0.42	103.59	24.65	511.08	650.51	360.05	414.53
VI2208-02-low	97.88	21.66	395.00	333.70	153.81	27.64	18.69	0.76	30.98	0.59	22.04	3.27	19.74	0.53	184.99	29.49	314.22	512.85	399.06	331.48
VI2208-03-low	25.45	11.34	172.81	134.81	72.33	13.28	15.84	1.11	18.83	4.60	10.79	1.32	12.43	1.71	82.05	14.21	587.83	692.87	406.11	465.74
VI2208-04-low	29.61	6.51	210.89	271.04	75.36	15.98	14.46	1.35	16.78	0.93	12.68	1.22	9.52	0.40	86.24	16.85	513.56	592.11	452.41	342.67
VI2208-05-low	27.36	7.03	203.37	208.45	74.20	14.65	17.89	1.02	15.99	0.61	8.97	0.31	11.25	0.08	84.48	15.47	642.02	576.82	329.75	411.22
VI2208-06-low	79.51	16.26	361.26	239.28	137.68	30.68	18.77	3.82	28.27	5.35	17.20	5.30	21.40	3.29	163.64	32.44	355.75	528.47	326.64	403.98
VI2208-07-low	186.18	35.10	624.13	449.00	249.86	47.38	15.36	0.45	25.85	0.83	11.20	0.55	12.39	0.36	307.04	50.46	157.55	262.93	115.30	127.36
VI2208-08-low	23.61	5.16	192.61	232.49	71.00	13.19			16.76	3.43			11.08	1.05	80.21	13.90		633.84		425.79
VI2208-09-low	78.59	17.96	288.93	292.52	127.42	28.67	17.72	1.09	21.37	1.62	14.86	1.58	18.55	0.56	152.65	30.41	359.88	431.53	303.10	376.20
VI2208-10-low	98.36	27.79	392.82	271.18	148.89	35.48			39.57	2.47	46.07	16.77	15.41	0.81	179.94	37.84		665.49	768.59	267.33
VI2208-11	172.68	37.37	674.29	384.26	252.47	56.73	17.92	1.29	23.70	0.81	17.21	1.09	18.94	0.56	306.54	60.23	183.75	241.92	176.50	193.98
VI2208-12-low	82.99	19.32	446.37	298.85	161.51	40.30			34.43	0.66	21.40	0.74	15.79	0.63	189.50	42.57		554.64	350.29	260.27
VI2208-13-low	43.00	9.47	211.06	255.19	87.07	15.70	15.73	1.44	21.60	0.46	13.05	1.21	15.79	0.46	101.75	16.64	475.08	643.67	396.40	476.71
VI2208-14-low	31.16	8.72	222.68	252.58	82.47	13.04	11.68	4.66	24.07	0.65	29.31	1.28	10.23	0.16	94.08	13.85	384.14	768.16	923.80	337.82
VI2208-15-low	74.14	20.52	389.08	322.32	137.79	30.36			40.21	1.17			19.15	0.58	162.47	32.26		744.32		365.27
VI2208-16-low	82.05	17.30	367.52	258.81	144.43	27.77	16.76	0.97	36.74	1.12	16.36	0.31	15.98	0.52	171.34	29.45	304.61	649.71	297.37	290.59
VI2208-17-low	110.33	34.05	461.79	335.99	181.00	53.63	19.62	1.22	32.55	0.84	24.41	0.55	25.33	0.96	216.53	56.90	282.57	462.30	349.71	362.54
VI2208-18-low	46.06	8.64	234.30	294.45	97.22	17.85			33.43	1.17	41.10	1.80	15.53	0.65	113.13	18.86		879.20	1065.20	423.51
VI2208-19-low	66.77	11.61	339.27	320.95	136.12	22.28			40.05	1.13	59.23	2.80	18.73	0.43	158.95	23.56		757.02	1090.42	365.15
VI2208-20-low	26.44	6.69	212.57	261.51	83.94	21.37	16.66	0.67	17.02	5.55	14.11	0.76	14.66	0.24	94.49	22.50	538.88	550.13	459.21	476.61
VI2208-21-low	117.84	26.10	544.74	424.00	185.25	33.67	21.36	2.61	52.47	0.95	67.70	2.42	20.54	0.49	222.79	35.90	298.56	710.23	902.58	287.47
VI2208-22-low	79.48	22.49	524.45	428.87	166.47	31.10	20.02	1.84	32.34	1.59	25.08	0.88	24.99	1.18	193.87	33.09	321.12	511.05	399.83	398.41
VI2208-23-low	27.59	6.70	205.15	240.06	70.39	11.40	15.98	0.67	17.75	0.96	9.60	0.48	9.83	0.22	80.53	12.08	603.41	666.79	369.33	377.79
VI2208-24-low	48.06	12.19	258.19	214.43	90.61	19.86	15.90	1.43	27.74	2.09	15.21	0.84	14.00	0.27	106.67	21.06	458.61	779.90	439.32	405.47
VI2208-25-low	31.21	22.16	186.45	231.85	71.91	32.27			33.08	1.27			15.00	0.83	82.99	34.30		1159.84		552.02
VI2208-26-core-lo	70.25	15.53	335.58	361.45	126.06	31.28	17.48	1.23	39.89	1.37	18.42	1.01	16.27	0.51	149.22	33.06	362.94	800.47	382.07	338.57
VI2208-26-rim-low	36.48	10.60	238.17	256.86	100.17	20.75	14.21	0.40	18.98	0.81	8.43	0.60	9.97	0.31	113.94	21.93	385.83	510.41	231.61	273.19
VI2208-27-low	122.20	30.10	474.97	368.48	181.35	38.45	19.68	2.37	38.23	0.74	27.82	10.17	22.04	0.55	219.74	41.02	279.36	532.10	391.44	312.13
VI2208-28-low	145.15	25.08	634.36	461.24	222.45	47.08	21.10	1.53	37.47	2.00	29.61	1.61	29.97	2.50	268.41	49.80	245.90	430.40	342.39	346.45
VI2208-29-low	28.50	9.30	221.05	219.39	86.57	27.90	14.64	1.01	12.60	0.21	7.13	0.70	10.25	1.03	97.74	29.38	460.78	398.49	228.60	326.05
VI2208-30-core-lo	75.50	13.96	358.65	343.13	133.08	27.34			39.81	3.70	25.82	1.08	17.39	0.92	157.85	28.90		757.75	501.45	341.94
VI2208-30-rim-low	32.97	8.96	224.52	267.22	89.79	23.70	10.33	1.18	17.69	1.78	6.08	0.80	8.86	0.82	102.19	24.98	314.48	529.52	186.92	270.77
VI2208-31	164.75	44.97	649.78	374.54	237.03	65.47			53.25	6.63			24.78	2.08	288.42	69.58		563.25		268.23
VI2208-32-low	80.68	14.45	438.29	347.52	153.86	28.16			39.01	1.00	78.96	8.16	18.72	0.56	180.92	29.77		653.21	1259.90	321.66
VI2208-01-high	97.27	26.47	371.79	267.67	157.13	26.36	17.28	2.06	22.24	2.83	12.03	1.53	13.91	0.42	188.33	28.40	286.10	365.88	200.52	231.29
VI2208-02-high	78.92	11.11	325.47	234.13	135.07	14.74	18.69	0.76	30.98	0.59	22.04	3.27	19.74	0.53	160.77	15.71	360.26	586.70	422.87	379.97
VI2208-03-high	73.07	14.01	290.15	287.47	124.85	20.37	15.84	1.11	18.83	4.60	10.79	1.32	12.43	1.71	148.63	21.65	331.12	391.68	227.35	261.27
VI2208-04-high	27.69	6.52	161.11	169.71	68.56	10.27	14.46	1.35	16.78	0.93	12.68	1.22	9.52	0.40	78.64	10.89	561.09	646.56	494.50	374.85
VI2208-05-high	32.63	5.69	213.49	188.59	84.39	17.17	17.89	1.02	15.99	0.61	8.97	0.31	11.25	0.08	96.44	18.08	565.81	508.04	289.77	361.63
VI2208-06-high	168.28	42.00	648.27	359.82	253.99	60.96	18.77	3.82	28.27	5.35	17.20	5.30	21.40	3.29	307.07	64.80	192.02	287.01	176.12	218.43
VI2208-07-high	152.53	29.88	657.36	393.16	246.77	30.99	15.36	0.45	25.85	0.83	11.20	0.55	12.39	0.36	295.71	33.33	163.51	272.79	119.68	132.19
VI2208-08-high	53.87	21.57	270.92	277.68	99.36	27.43			16.76	3.43			11.08	1.05	117.26	29.26		440.24		294.29
VI2208-09-high	67.60	13.94	314.92	199.99	130.40	20.36	17.72	1.09	21.37	1.62	14.86	1.58	18.55	0.56	153.14	21.64	358.76	430.20	302.16	375.03
VI2208-10-high	83.70	16.08	371.30	307.35	139.50	39.75			39.57	2.47	46.07	16.77	15.41	0.81	166.56	41.91		716.08	826.53	288.32
VI2208-11	172.68	37.37	674.29	384.26	252.47	56.73	17.92	1.29	23.70	0.81	17.21	1.09	18.94	0.56	306.54	60.23	183.75	241.92	176.50	193.98
VI2208-12-high	110.25	16.87	573.41	331.18	224.36	37.55			34.43	0.66	21.40	0.74	15.79	0.63	262.04	39.63		405.81	255.21	189.26
VI2208-13-high	54.43	12.70	283.57	188.77	107.55	20.02	15.73	1.44	21.60	0.46	13.05	1.21	15.79	0.46	125.99	21.24	386.34	524.70	321.99	387.67
VI2208-14-high	29.43	7.30	247.72	275.50	91.97	20.07	11.68	4.66	24.07	0.65	29.31	1.28	10.23	0.16	103.64	21.15	349.64	701.01	843.90	307.38
VI2208-15-high	58.47	11.16	351.03	239.56	122.88	28.57			40.21	1.17			19.15	0.58	143.06	30.12		839.01		413.28
VI2208-16-high	66.88	15.48	448.21	260.96	152.40	26.48	16.76	0.97	36.74	1.12	16.36	0.31	15.98	0.52	176.07	28.06	296.60	633.07	289.56	282.94
VI2208-17-high	86.25	20.50	419.75	328.29	159.21	37.26	19.62	1.22	32.55	0.84	24.41	0.55	25.33	0.96	187.87	39.43	324.61	530.00	401.43	416.09
VI2208-18-high	56.98	11.24	294.57	204.47	109.14	20.78			33.43	1.17	41.10	1.80	15.53	0.65	128.27	21.98		781.48	948.28	374.96
VI2208-19-high	73.68	14.52	455.63	347.21	166.20	32.12			40.05	1.13	59.23	2.80	18.73	0.43	192.20	33.91		632.24	914.47	303.43
VI2208-20-high	77.57	10.87	347.74	262.97	142.04	13.40	16.66	0.67	17.02	5.55	14.11	0.76	14.66	0.24	167.75	14.31	309.04	315.61	262.66	272.77
VI2208-21-high	94.00	15.70	401.51	257.65	161.56	39.27	21.36	2.61	52.47	0.95	67.70	2.42	20.54	0.49	192.20	41.40	344.84	816.42	1035.30	332.08
VI2208-22-high	110.69	27.57	465.53	248.17	175.97	55.14	20.02	1.84	32.34	1.59	25.08	0.88								

Spot	$\omega 1^1$	$\omega 1 \text{ 2SD}^1$	$\Gamma 1^1$	$\Gamma 1 \text{ 2SD}^1$	$\omega 2^1$	$\omega 2 \text{ 2SD}^1$	$\Gamma 2^1$	$\Gamma 2 \text{ 2SD}^1$	$\omega 3^1$	$\omega 3 \text{ 2SD}^1$	$\Gamma 3^1$	$\Gamma 3 \text{ 2SD}^1$	ωR^1	$\omega R \text{ 2SD}^1$	ΓR^1	$\Gamma R \text{ 2SD}^1$
V12206-01	972.34	0.78	4.68	1.12	439.00	0.78	10.50	1.37	1005.77	0.90	6.22	0.96	353.72	0.74	8.81	0.63
V12206-02-low					439.20	2.21	12.11	5.07	1005.95	1.01	8.26	7.69	354.15	0.78	7.92	2.20
V12206-03-low	972.53	0.00	4.55	0.14	439.20	0.00	11.47	0.12	1005.38	0.00	6.02	0.07	353.96	0.00	7.76	0.09
V12206-04-low					438.42	0.00	9.86	0.18	1006.16	0.00	6.24	0.28	354.74	0.00	6.94	0.04
V12206-05-low	972.53	0.00	4.13	0.04	439.20	0.00	10.12	0.26	1006.16	0.00	4.83	0.04	353.96	0.00	7.08	0.10
V12206-06-low	971.75	0.00	5.11	1.01	438.61	0.78	11.14	1.03	1005.38	0.00	6.66	0.74	353.57	0.90	8.70	1.06
V12206-07-low	970.19	0.00	7.25	0.23	438.42	0.00	13.66	0.41	1003.81	0.00	8.93	0.17	352.39	0.00	11.29	0.20
V12206-08-low					439.98	0.00	14.97	1.76	1004.59	0.00	10.05	0.12	352.39	0.00	10.41	0.23
V12206-09-low	972.53	0.00	4.33	1.06	439.98	0.00	13.76	0.08	1006.16	0.00	7.37	0.14	353.96	0.00	8.01	0.04
V12206-10-low					439.35	0.26	17.28	0.90					353.37	0.78	10.36	1.67
V12206-11	973.12	0.78	3.88	0.27	438.42	0.00	8.11	1.69	1006.55	0.90	4.68	0.61	354.74	1.28	7.16	0.99
V12206-12-low					438.92	1.23	12.55	1.71					353.92	0.16	8.33	0.91
V12206-13-low					439.20	0.00	12.23	0.64	1006.00	0.63	5.63	0.27	353.96	0.00	7.27	0.04
V12206-14-low					439.20	0.00	11.91	0.10					354.74	0.00	7.87	0.06
V12206-15-low					439.20	0.00	12.48	0.16	1006.16	0.00	4.82	0.16	354.74	0.00	6.76	0.05
V12206-16-low					439.20	0.00	13.75	0.14	1004.59	0.00	8.84	0.60	353.96	0.00	8.52	0.04
V12206-17-low	972.53	0.00	4.52	0.13	439.20	0.00	10.86	0.41	1005.38	0.00	6.55	0.04	353.18	0.00	8.13	0.19
V12206-18	972.53	0.00	4.26	0.19	438.18	0.74	8.72	0.72	1005.38	0.00	5.07	0.46	354.55	0.78	7.07	0.32
V12206-19-low	972.73	0.78	3.23	0.21	438.42	0.00	9.27	0.70	1006.16	0.00	4.45	0.40	354.74	0.00	6.32	0.16
V12206-20-low	970.97	0.00	6.44	0.25	440.76	0.00	14.95	0.10	1004.59	0.00	7.91	0.06	353.18	0.00	10.07	0.15
V12206-21	971.44	0.77	5.69	0.25	439.98	0.00	14.23	0.22	1004.59	0.00	7.54	0.08	353.18	0.00	9.14	0.12
V12206-22					439.04	0.63	16.11	3.92					350.05	0.00	14.72	1.34
V12206-23-low	972.53	0.00	4.90	0.20	439.98	0.00	13.12	0.18	1005.38	0.00	5.49	0.05	353.96	0.00	7.70	0.09
V12206-24-low	972.53	0.00	3.50	0.39	439.20	0.00	11.15	1.19	1006.16	0.00	5.06	0.60	354.74	0.00	6.96	0.61
V12206-25-low	971.75	0.00	4.82	0.38	439.20	0.00	13.40	0.04	1005.38	0.00	6.34	0.07	353.96	0.00	8.41	0.09
V12206-26-low	972.92	0.90	3.89	0.62	438.42	0.00	8.02	0.53	1006.16	0.00	4.52	0.67	354.74	0.00	6.92	0.56
V12206-27-low	972.34	0.78	3.96	0.52	439.59	0.90	12.48	1.66	1005.96	0.78	7.04	1.71	353.96	0.00	7.87	0.84
V12206-28-low					439.20	0.00	10.48	0.67					354.74	0.00	6.89	0.29
V12206-29-low	972.34	0.78	4.57	0.49	438.61	0.78	9.62	1.32	1005.57	0.78	5.33	0.65	354.55	0.78	7.50	0.79
V12206-30-low					439.51	1.25	12.77	1.38					350.83	0.00	15.83	2.73
V12206-01	972.34	0.78	4.68	1.12	439.00	0.78	10.50	1.37	1005.77	0.90	6.22	0.96	353.72	0.74	8.81	0.63
V12206-02-high					439.20	2.21	12.11	5.07	1005.95	1.01	8.26	7.69	354.15	0.78	7.92	2.20
V12206-03-high	972.53	0.00	4.55	0.14	439.20	0.00	11.47	0.12	1005.38	0.00	6.02	0.07	353.96	0.00	7.76	0.09
V12206-04-high					438.42	0.00	9.86	0.18	1006.16	0.00	6.24	0.28	354.74	0.00	6.94	0.04
V12206-05-high	972.53	0.00	4.13	0.04	439.20	0.00	10.12	0.26	1006.16	0.00	4.83	0.04	353.96	0.00	7.08	0.10
V12206-06-high	971.75	0.00	5.11	1.01	438.61	0.78	11.14	1.03	1005.38	0.00	6.66	0.74	353.57	0.90	8.70	1.06
V12206-07-high	970.19	0.00	7.25	0.23	438.42	0.00	13.66	0.41	1003.81	0.00	8.93	0.17	352.39	0.00	11.29	0.20
V12206-08-high					439.98	0.00	14.97	1.76	1004.59	0.00	10.05	0.12	352.39	0.00	10.41	0.23
V12206-09-high	972.53	0.00	4.33	1.06	439.98	0.00	13.76	0.08	1006.16	0.00	7.37	0.14	353.96	0.00	8.01	0.04
V12206-10-high					439.35	0.26	17.28	0.90					353.37	0.78	10.36	1.67
V12206-11	973.12	0.78	3.88	0.27	438.42	0.00	8.11	1.69	1006.55	0.90	4.68	0.61	354.74	1.28	7.16	0.99
V12206-12-high					438.92	1.23	12.55	1.71					353.92	0.16	8.33	0.91
V12206-13-high					439.20	0.00	12.23	0.64	1006.00	0.63	5.63	0.27	353.96	0.00	7.27	0.04
V12206-14-high					439.20	0.00	11.91	0.10					354.74	0.00	7.87	0.06
V12206-15-high					439.20	0.00	12.48	0.16	1006.16	0.00	4.82	0.16	354.74	0.00	6.76	0.05
V12206-16-high					439.20	0.00	13.75	0.14	1004.59	0.00	8.84	0.60	353.96	0.00	8.52	0.04
V12206-17-high	972.53	0.00	4.52	0.13	439.20	0.00	10.86	0.41	1005.38	0.00	6.55	0.04	353.18	0.00	8.13	0.19
V12206-18	972.53	0.00	4.26	0.19	438.18	0.74	8.72	0.72	1005.38	0.00	5.07	0.46	354.55	0.78	7.07	0.32
V12206-19-high	972.73	0.78	3.23	0.21	438.42	0.00	9.27	0.70	1006.16	0.00	4.45	0.40	354.74	0.00	6.32	0.16
V12206-20-high	970.97	0.00	6.44	0.25	440.76	0.00	14.95	0.10	1004.59	0.00	7.91	0.06	353.18	0.00	10.07	0.15
V12206-21	971.44	0.77	5.69	0.25	439.98	0.00	14.23	0.22	1004.59	0.00	7.54	0.08	353.18	0.00	9.14	0.12
V12206-22					439.04	0.63	16.11	3.92					350.05	0.00	14.72	1.34
V12206-23-high	972.53	0.00	4.90	0.20	439.98	0.00	13.12	0.18	1005.38	0.00	5.49	0.05	353.96	0.00	7.70	0.09
V12206-24-high	972.53	0.00	3.50	0.39	439.20	0.00	11.15	1.19	1006.16	0.00	5.06	0.60	354.74	0.00	6.96	0.61
V12206-25-high	971.75	0.00	4.82	0.38	439.20	0.00	13.40	0.04	1005.38	0.00	6.34	0.07	353.96	0.00	8.41	0.09
V12206-26-high	972.92	0.90	3.89	0.62	438.42	0.00	8.02	0.53	1006.16	0.00	4.52	0.67	354.74	0.00	6.92	0.56
V12206-27-high	972.34	0.78	3.96	0.52	439.59	0.90	12.48	1.66	1005.96	0.78	7.04	1.71	353.96	0.00	7.87	0.84
V12206-28-high					439.20	0.00	10.48	0.67					354.74	0.00	6.89	0.29
V12206-29-high	972.34	0.78	4.57	0.49	438.61	0.78	9.62	1.32	1005.57	0.78	5.33	0.65	354.55	0.78	7.50	0.79
V12206-30-high					439.51	1.25	12.77	1.38					350.83	0.00	15.83	2.73

Spot	Th232 (ppm)	Th232 2SD ²	U235 (ppm)	U235 2SD ²	U238 (ppm)	U238 2SD ²	D1 (10 ¹⁶ α/g) ³	D1 2SD ³	D2 (10 ¹⁶ α/g) ³	D2 2SD ³	D3 (10 ¹⁶ α/g) ³	D3 2SD ³	Der (10 ¹⁶ α/g) ³	Der 2SD ³	eU (ppm)	eU 2SD ²	Date1 (Ma) ⁴	Date2 (Ma) ⁴	Date3 (Ma) ⁴	DateER (Ma) ⁴
VI2206-01	190.18	68.57	811.24	410.24	284.70	83.67	26.36	10.48	37.89	9.72	30.35	8.68	28.07	3.68	344.57	89.38	239.37	341.38	274.88	254.61
VI2206-02-low	115.86	35.66	472.78	410.55	158.99	34.42			49.27	35.93	48.78	69.30	22.86	12.87	194.74	37.14		759.99	752.79	363.74
VI2206-03-low	143.15	32.19	579.34	493.37	198.63	44.27	25.08	1.29	44.77	0.83	28.54	0.66	21.93	0.54	242.92	47.12	320.96	562.35	364.11	281.62
VI2206-04-low	164.61	40.21	733.28	403.06	238.12	36.16			33.33	1.30	30.52	2.53	17.16	0.22	289.53	39.18		356.95	327.55	186.24
VI2206-05-low	118.51	20.13	548.57	363.63	179.66	27.82	21.14	0.33	35.20	1.81	17.81	0.36	17.97	0.60	217.09	29.61	303.15	497.31	256.34	258.57
VI2206-06-low	253.64	57.50	1001.33	590.55	314.47	64.07	30.31	9.43	42.38	7.31	34.33	6.69	27.45	6.21	391.07	68.68	242.48	336.56	273.95	219.98
VI2206-07-low	587.05	131.61	2280.21	893.65	740.57	147.20	50.34	2.12	60.29	2.89	54.77	1.49	42.55	1.18	918.50	157.76	172.41	205.94	187.35	146.01
VI2206-08-low	868.02	184.63	1954.98	1115.13	613.15	126.95			69.57	12.51	64.85	1.05	37.41	1.36	852.13	140.47		255.15	238.14	138.45
VI2206-09-low	204.22	32.27	866.47	540.43	266.52	33.66	23.06	9.94	60.98	0.56	40.73	1.25	23.41	0.26	328.86	36.18	219.74	565.61	383.26	222.98
VI2206-10-low	842.42	544.63	2819.36	1659.97	907.26	332.28			85.95	6.35			37.14	9.77	1154.80	372.57		233.02		101.71
VI2206-11	98.12	34.74	397.34	384.33	134.04	23.76	18.83	2.50	20.90	11.97	16.49	5.47	18.41	5.78	164.29	26.31	355.40	393.37	312.37	347.62
VI2206-12-low	1103.94	248.57	1519.90	1007.56	533.15	127.95			52.44	12.14			25.27	5.32	824.76	147.00		199.57		96.96
VI2206-13-low	110.38	28.30	516.28	453.02	144.75	33.00			50.13	4.55	25.08	2.46	19.06	0.26	178.48	35.31		838.54	433.19	331.84
VI2206-14-low	127.68	26.70	581.31	408.01	182.15	36.41			47.87	0.74			22.57	0.34	221.90	38.77		653.42		316.34
VI2206-15-low	57.03	16.75	293.86	281.42	107.77	31.20			51.95	1.11	17.77	1.44	16.09	0.30	126.84	33.01		1188.98	431.93	392.22
VI2206-16-low	212.36	78.33	897.46	568.67	321.37	68.83			60.95	0.98	53.97	5.38	26.37	0.23	388.41	74.67		481.81	428.40	212.88
VI2206-17-low	152.87	29.63	609.67	472.92	201.11	33.95	24.87	1.19	40.44	2.92	33.29	0.37	24.08	1.12	247.85	36.35	312.18	500.29	414.62	302.52
VI2206-18	160.76	68.90	692.74	452.65	225.14	63.87	22.41	1.74	25.23	5.11	20.04	4.11	17.91	1.84	274.98	69.07	254.76	286.05	228.24	204.37
VI2206-19-low	129.78	31.66	485.36	416.36	157.77	32.91	12.80	2.01	29.15	4.95	14.43	3.62	13.53	0.95	196.80	35.38	204.11	455.65	229.65	215.53
VI2206-20-low	369.56	86.09	1319.80	764.77	424.65	85.94	42.75	2.37	69.46	0.74	45.58	0.55	35.43	0.89	534.57	92.57	250.03	401.48	266.23	207.90
VI2206-21	1201.65	424.88	2928.09	1346.47	949.07	311.78	35.80	2.37	64.34	1.56	42.28	0.76	29.98	0.72	1284.92	342.89	88.22	157.69	104.04	73.96
VI2206-22	5635.01	1634.11	7511.41	1948.87	2659.96	521.99			77.65	27.81			62.62	7.81	4145.36	673.95		59.44		47.98
VI2206-23-low	293.09	78.41	734.82	629.32	251.91	44.76	28.40	1.83	56.47	1.28	23.79	0.46	21.57	0.54	334.85	50.63	264.88	516.37	222.56	202.19
VI2206-24-low	104.18	24.86	474.56	431.36	173.10	57.43	15.33	3.63	42.48	8.44	19.92	5.40	17.23	3.57	206.76	60.59	232.08	623.82	300.09	260.37
VI2206-25-low	151.67	51.50	637.15	390.85	235.09	63.56	27.63	3.56	58.42	0.29	31.40	0.61	25.70	0.55	283.24	67.88	303.66	626.12	344.10	282.98
VI2206-26-low	62.76	20.88	300.58	330.67	105.83	29.35	18.90	5.78	20.32	3.75	15.02	6.02	17.02	3.26	126.18	31.22	460.74	493.86	368.77	416.31
VI2206-27-low	246.49	106.11	976.78	609.22	285.65	59.61	19.61	4.86	51.91	11.80	37.79	15.37	22.56	4.91	359.09	67.57	171.79	445.10	327.06	197.23
VI2206-28-low	224.68	39.00	1000.41	557.83	312.72	87.85			37.76	4.76			16.84	1.68	382.28	92.72		307.45		138.91
VI2206-29-low	87.34	18.52	643.89	549.94	206.05	44.31	25.27	4.62	31.64	9.33	22.35	5.82	20.43	4.60	237.31	46.74	330.79	411.57	293.51	268.79
VI2206-30-low	551.81	137.61	2702.72	1221.70	820.89	167.77			53.98	9.76			69.11	15.99	994.37	179.23		170.78		217.84
VI2206-01	190.18	68.57	811.24	410.24	284.70	83.67	26.36	10.48	37.89	9.72	30.35	8.68	28.07	3.68	344.57	89.38	239.37	341.38	274.88	254.61
VI2206-02-high	286.53	83.73	938.16	495.60	320.18	78.63			49.27	35.93	48.78	69.30	22.86	12.87	404.96	84.97		376.66	372.99	177.48
VI2206-03-high	190.40	50.67	781.61	427.64	256.15	50.10	25.08	1.29	44.77	0.83	28.54	0.66	21.93	0.54	314.65	53.99	249.18	438.39	282.89	218.49
VI2206-04-high	157.64	59.49	623.84	395.38	223.06	71.93			33.33	1.30	30.52	2.53	17.16	0.22	272.05	76.87		379.22	348.05	198.02
VI2206-05-high	226.55	49.80	807.78	491.97	278.80	43.96	21.14	0.33	35.20	1.81	17.81	0.36	17.97	0.60	347.12	47.68	191.25	315.48	161.50	162.92
VI2206-06-high	584.22	138.50	1352.19	661.29	461.58	137.95	30.31	9.43	42.38	7.31	34.33	6.69	27.45	6.21	624.87	148.62	152.82	212.68	172.81	138.55
VI2206-07-high	1274.74	351.43	3130.06	989.43	1072.46	191.78	50.34	2.12	60.29	2.89	54.77	1.49	42.55	1.18	1432.02	218.32	111.11	132.84	120.79	94.03
VI2206-08-high	871.02	181.66	2092.25	784.50	688.22	123.41			69.57	12.51	64.85	1.05	37.41	1.36	931.68	136.72		233.75	218.15	126.74
VI2206-09-high	172.71	47.57	800.99	466.60	271.97	75.59	23.06	9.94	60.98	0.56	40.73	1.25	23.41	0.26	327.02	80.18	220.95	568.66	385.36	224.22
VI2206-10-high	2384.91	1277.86	5189.78	1767.41	1708.11	513.23			85.95	6.35			37.14	9.77	2365.90	620.05		114.79		49.85
VI2206-11	98.12	34.74	397.34	384.33	134.04	23.76	18.83	2.50	20.90	11.97	16.49	5.47	18.41	5.78	164.29	26.31	355.40	393.37	312.37	347.62
VI2206-12-high	1449.85	618.72	1777.49	952.09	605.26	205.05			52.44	12.14			25.27	5.32	983.48	261.54		167.77		81.41
VI2206-13-high	164.58	36.07	588.18	430.04	196.10	41.13			50.13	4.55	25.08	2.46	19.06	0.26	245.40	44.05		620.45	317.91	243.02
VI2206-14-high	169.92	41.28	630.85	414.38	209.68	58.63			47.87	0.74			22.57	0.34	260.95	62.35		559.76		269.98
VI2206-15-high	88.34	23.52	517.60	323.03	172.63	69.36			51.95	1.11	17.77	1.44	16.09	0.30	202.46	73.05		770.11	273.97	248.50
VI2206-16-high	426.21	296.06	1595.96	871.59	539.01	175.59			60.95	0.98	53.97	5.38	26.37	0.23	668.25	197.59		284.41	252.45	124.59
VI2206-17-high	171.02	36.37	727.59	319.61	244.53	35.65	24.87	1.19	40.44	2.92	33.29	0.37	24.08	1.12	297.80	38.44	260.87	419.05	346.91	252.76
VI2206-18	160.76	68.90	692.74	452.65	225.14	63.87	22.41	1.74	25.23	5.11	20.04	4.11	17.91	1.84	274.98	69.07	254.76	286.05	228.24	204.37
VI2206-19-high	113.82	66.82	499.76	406.32	160.12	54.57	12.80	2.01	29.15	4.95	14.43	3.62	13.53	0.95	195.44	59.50	205.51	458.72	231.22	217.01
VI2206-20-high	459.66	147.89	1537.39	671.19	485.83	109.26	42.75	2.37	69.46	0.74	45.58	0.55	35.43	0.89	620.44	120.09	215.99	347.38	230.03	179.52
VI2206-21	1201.65	424.88	2928.09	1346.47	949.07	311.78	35.80	2.37	64.34	1.56	42.28	0.76	29.98	0.72	1284.92	342.89	88.22	157.69	104.04	73.96
VI2206-22	5635.01	1634.11	7511.41	1948.87	2659.96	521.99			77.65	27.81			62.62	7.81	4145.36	673.95		59.44		47.98
VI2206-23-high	462.00	88.10	1068.84	495.85	333.98	44.57	28.40	1.83	56.47	1.28	23.79	0.46	21.57	0.54	461.56	51.35	193.24	378.67	162.22	147.31
VI2206-24-high	368.05	113.31	1170.87	473.69	387.26	90.66	15.33	3.63	42.48	8.44	19.92	5.40	17.23	3.57	494.96	99.00	97.96	267.96	127.05	110.04
VI2206-25-high	935.03	222.17	2475.18	1147.17	785.93	116.01	27.63	3.56	58.42	0.29	31.40	0.61	25.70	0.55	1049.63	132.97	83.36	175.03	94.68	77.59
VI2206-26-high	104.93	17.79	815.58	634.78	283.51	71.23	18.90	5.78	20.32	3.75	15.02	6.02								

Spot	$\omega 1^1$	$\omega 1\ 2SD^1$	$\Gamma 1^1$	$\Gamma 1\ 2SD^1$	$\omega 2^1$	$\omega 2\ 2SD^1$	$\Gamma 2^1$	$\Gamma 2\ 2SD^1$	$\omega 3^1$	$\omega 3\ 2SD^1$	$\Gamma 3^1$	$\Gamma 3\ 2SD^1$	ωR^1	$\omega R\ 2SD^1$	ΓR^1	$\Gamma R\ 2SD^1$
VI2001-01-low					439.98	0.00	12.78	0.03	1006.16	0.00	4.75	0.08	354.74	0.00	6.53	0.03
VI2001-02-low	972.67	0.00	4.35	0.04	439.44	0.00	11.79	0.31	1006.11	0.00	6.23	0.44	354.69	0.00	7.30	0.03
VI2001-03-low					438.65	0.16	9.86	0.40	1007.25	0.77	17.85	0.64	354.90	0.16	7.07	0.07
VI2001-04-low	973.08	0.00	3.54	0.59	438.82	0.00	9.58	0.16	1006.52	0.00	4.81	0.09	355.32	0.00	6.38	0.02
VI2001-05-low	972.87	0.00	3.73	0.24	439.44	0.00	10.52	0.13	1006.32	0.00	4.59	0.03	355.11	0.00	6.50	0.04
VI2001-06	972.87	0.00	4.62	0.03	437.99	0.00	8.33	0.10	1005.49	0.00	5.05	0.02	355.11	0.00	6.54	0.07
VI2001-07-low	972.87	0.00	3.83	0.03	438.61	0.00	9.07	0.19	1006.11	0.00	4.90	0.11	355.52	0.00	6.10	0.03
VI2001-08-low	972.46	0.00	4.16	0.45	439.30	0.00	11.47	0.43	1005.73	0.00	5.85	0.04	354.52	0.00	7.23	0.03
VI2001-09-low	972.96	0.20	3.96	0.03	438.61	0.00	8.82	0.51	1006.94	0.00	4.55	0.03	355.52	0.00	6.53	0.04
VI2001-10					438.46	0.16	9.42	0.10	1006.16	0.00	7.33	0.08	355.13	0.00	6.60	0.02
VI2001-11-low	972.87	0.00	4.07	0.03	438.82	0.00	9.43	0.04	1006.11	0.00	4.87	0.02	354.69	0.00	6.72	0.04
VI2001-12					438.22	0.00	9.35	0.32	1006.00	0.16	7.47	1.67	354.74	0.00	7.00	0.04
VI2001-13					439.35	0.16	12.58	0.40	1006.12	0.16	7.35	1.83	354.74	0.00	7.46	0.04
VI2001-14-low	972.87	0.00	4.06	0.03	438.61	0.00	8.63	0.09	1006.11	0.00	4.68	0.04	354.69	0.00	7.03	0.05
VI2001-15-l					439.59	0.00	12.78	0.05	1005.96	0.31	6.70	1.12	354.70	0.16	7.06	0.05
VI2001-16-core	973.70	0.00	3.51	1.08	438.61	0.00	8.25	0.10	1006.94	0.00	4.70	0.04	355.52	0.00	6.00	0.02
VI2001-16-rim-l					438.42	0.00	8.25	0.27	1006.16	0.00	5.74	0.04	355.52	0.00	6.30	0.02
VI2001-17-l	972.87	0.00	4.22	0.06	439.44	0.00	8.96	0.96	1006.94	0.00	4.96	0.04	354.69	0.00	7.97	0.17
VI2001-18-l	972.87	0.00	4.09	0.05	438.61	0.00	9.30	0.04	1006.11	0.00	4.93	0.04	353.86	0.00	7.72	0.11
VI2001-19	972.87	0.00	4.20	0.03	438.61	0.00	9.58	0.04	1006.11	0.00	4.91	0.03	354.69	0.00	7.35	0.05
VI2001-20-l	972.87	0.00	4.08	0.04	438.82	0.00	8.88	0.46	1006.11	0.00	5.03	0.04	354.48	0.00	7.48	0.09
VI2001-21-l					438.73	0.77	9.71	0.25	1006.16	0.00	6.21	0.04	354.74	0.00	6.79	0.02
VI2001-22	972.87	0.00	3.84	0.34	442.48	0.20	29.71	0.99	1006.11	0.00	4.46	0.02	354.69	0.00	6.28	0.02
VI2001-23					439.59	0.00	12.93	0.03	1011.24	0.38	64.53	1.43	354.55	0.00	7.50	0.03
VI2001-24-core	972.87	0.00	3.56	0.04	438.61	0.00	9.10	0.11	1006.11	0.00	4.71	0.03	354.69	0.00	7.04	0.07
VI2001-24-rim-l	972.04	0.00	4.53	0.01	439.44	0.00	11.55	0.07	1005.28	0.00	6.44	0.05	353.86	0.00	8.13	0.05
VI2001-25-l	972.87	0.00	4.19	0.03	439.11	0.81	9.66	0.05	1006.11	0.00	4.99	0.04	354.69	0.00	7.19	0.11
VI2001-26-l					438.85	0.16	10.79	0.40	1009.36	7.22	32.75	55.74	354.94	0.00	7.04	0.03
VI2001-27-l	972.04	0.00	5.09	0.02	439.03	0.00	11.74	0.12	1005.28	0.00	6.62	0.02	353.86	0.00	8.13	0.07
VI2001-28-l					439.35	0.16	11.60	0.42	1018.62	0.46	84.06	0.12	354.15	0.00	7.47	0.04
VI2001-29-l					439.39	0.00	12.21	0.19	1009.48	0.00	35.66	0.82	354.27	0.19	8.14	0.01
VI2001-30-l	972.25	0.00	4.14	0.04	438.61	0.00	10.07	0.14	1005.49	0.00	5.34	0.04	354.07	0.00	7.42	0.08
VI2001-31-l					439.08	0.19	10.53	0.10	1007.29	2.19	14.58	22.44	355.13	0.00	7.03	0.03
VI2001-32-l	973.70	0.00	4.40	0.05	438.82	0.00	8.28	0.29	1006.94	0.00	4.77	0.03	355.52	0.00	7.15	0.07
VI2001-33-l	973.50	0.00	3.97	0.31	438.82	0.00	8.77	0.05	1006.52	0.00	4.70	0.07	355.32	0.00	6.42	0.02
VI2001-34-l	973.29	0.00	3.62	0.57	439.03	0.00	9.92	0.15	1006.52	0.00	4.82	0.04	355.48	0.17	6.56	0.02
VI2001-35					439.35	0.16	12.45	0.43	1007.88	6.88	23.29	42.10	354.35	0.00	7.82	0.04
VI2001-01-high					439.98	0.00	12.78	0.03	1006.16	0.00	4.75	0.08	354.74	0.00	6.53	0.03
VI2001-02-high	972.67	0.00	4.35	0.04	439.44	0.00	11.79	0.31	1006.11	0.00	6.23	0.44	354.69	0.00	7.30	0.03
VI2001-03-high					438.65	0.16	9.86	0.40	1007.25	0.77	17.85	0.64	354.90	0.16	7.07	0.07
VI2001-04-high	973.08	0.00	3.54	0.59	438.82	0.00	9.58	0.16	1006.52	0.00	4.81	0.09	355.32	0.00	6.38	0.02
VI2001-05-high	972.87	0.00	3.73	0.24	439.44	0.00	10.52	0.13	1006.32	0.00	4.59	0.03	355.11	0.00	6.50	0.04
VI2001-06	972.87	0.00	4.62	0.03	437.99	0.00	8.33	0.10	1005.49	0.00	5.05	0.02	355.11	0.00	6.54	0.07
VI2001-07-high	972.87	0.00	3.83	0.03	438.61	0.00	9.07	0.19	1006.11	0.00	4.90	0.11	355.52	0.00	6.10	0.03
VI2001-08-high	972.46	0.00	4.16	0.45	439.30	0.00	11.47	0.43	1005.73	0.00	5.85	0.04	354.52	0.00	7.23	0.03
VI2001-09-high	972.96	0.20	3.96	0.03	438.61	0.00	8.82	0.51	1006.94	0.00	4.55	0.03	355.52	0.00	6.53	0.04
VI2001-10					438.46	0.16	9.42	0.10	1006.16	0.00	7.33	0.08	355.13	0.00	6.60	0.02
VI2001-11-high	972.87	0.00	4.07	0.03	438.82	0.00	9.43	0.04	1006.11	0.00	4.87	0.02	354.69	0.00	6.72	0.04
VI2001-12					438.22	0.00	9.35	0.32	1006.00	0.16	7.47	1.67	354.74	0.00	7.00	0.04
VI2001-13					439.35	0.16	12.58	0.40	1006.12	0.16	7.35	1.83	354.74	0.00	7.46	0.04
VI2001-14-high	972.87	0.00	4.06	0.03	438.61	0.00	8.63	0.09	1006.11	0.00	4.68	0.04	354.69	0.00	7.03	0.05
VI2001-15-h					439.59	0.00	12.78	0.05	1005.96	0.31	6.70	1.12	354.70	0.16	7.06	0.05
VI2001-16-core	973.70	0.00	3.51	1.08	438.61	0.00	8.25	0.10	1006.94	0.00	4.70	0.04	355.52	0.00	6.00	0.02
VI2001-16-rim-h					438.42	0.00	8.25	0.27	1006.16	0.00	5.74	0.04	355.52	0.00	6.30	0.02
VI2001-17-h	972.87	0.00	4.22	0.06	439.44	0.00	8.96	0.96	1006.94	0.00	4.96	0.04	354.69	0.00	7.97	0.17
VI2001-18-h	972.87	0.00	4.09	0.05	438.61	0.00	9.30	0.04	1006.11	0.00	4.93	0.04	353.86	0.00	7.72	0.11
VI2001-19	972.87	0.00	4.20	0.03	438.61	0.00	9.58	0.04	1006.11	0.00	4.91	0.03	354.69	0.00	7.35	0.05
VI2001-20-h	972.87	0.00	4.08	0.04	438.82	0.00	8.88	0.46	1006.11	0.00	5.03	0.04	354.48	0.00	7.48	0.09
VI2001-21-h					438.73	0.77	9.71	0.25	1006.16	0.00	6.21	0.04	354.74	0.00	6.79	0.02
VI2001-22	972.87	0.00	3.84	0.34	442.48	0.20	29.71	0.99	1006.11	0.00	4.46	0.02	354.69	0.00	6.28	0.02
VI2001-23					439.59	0.00	12.93	0.03	1011.24	0.38	64.53	1.43	354.55	0.00	7.50	0.03
VI2001-24-core	972.87	0.00	3.56	0.04	438.61	0.00	9.10	0.11	1006.11	0.00	4.71	0.03	354.69	0.00	7.04	0.07
VI2001-24-rim-h	972.04	0.00	4.53	0.01	439.44	0.00	11.55	0.07	1005.28	0.00	6.44	0.05	353.86	0.00	8.13	0.05
VI2001-25-h	972.87	0.00	4.19	0.03	439.11	0.81	9.66	0.05	1006.11	0.00	4.99	0.04	354.69	0.00	7.19	0.11
VI2001-26-h					438.85	0.16	10.79	0.40	1009.36	7.22	32.75	55.74	354.94	0.00	7.04	0.03
VI2001-27-h	972.04	0.00	5.09	0.02	439.03	0.00	11.74	0.12	1005.28	0.00	6.62	0.02	353.86	0.00	8.13	0.07
VI2001-28-h					439.35	0.16	11.60	0.42	1018.62	0.46	84.06	0.12	354.15	0.00	7.47	0.04
VI2001-29-h					439.39	0.00	12.21	0.19	1009.48	0.00	35.66	0.82	354.27	0.19	8.14	0.01
VI2001-30-h	972.25	0.00	4.14	0.04	438.61	0.00	10.07	0.14	1005.49	0.00	5.34	0.04	354.07	0.00	7.42	0.08
VI2001-31-h					439.08	0.19	10.53	0.10	1007.29	2.19	14.58	22.44	355.13	0.00	7.03	0.03
VI2001-32-h	973.70	0.00	4.40	0.05	438.82	0.00	8.28	0.29	1006.94	0.00	4.77	0.03	355.52	0.00	7.15	0.07
VI2001-33-h	973.50	0.00	3.97	0.31	438.82	0.00	8.77	0.05	1006.52	0.00	4.70	0.07	355.32	0.00	6.42	0.02
VI2001-34-h	973.29	0.00	3.62	0.57	439.03	0.00	9.92	0.15	1006.52	0.00	4.82	0.04	355.48	0.17	6.56	0.02
VI2001-35					439.35	0.16										

Spot	Th232 (ppm)	Th232 2SD ²	U235 (ppm)	U235 2SD ²	U238 (ppm)	U238 2SD ²	D1 (10 ⁻⁶ α/g) ³	D1 2SD ³	D2 (10 ⁻⁶ α/g) ³	D2 2SD ³	D3 (10 ⁻⁶ α/g) ³	D3 2SD ³	Der (10 ⁻⁶ α/g) ³	Der 2SD ³	eU (ppm)	eU 2SD ²	Date1 (Ma) ⁴	Date2 (Ma) ⁴	Date3 (Ma) ⁴	DateER (Ma) ⁴
V2001-01-low	94.14	33.63	843.38	573.46	212.17	45.18			54.02	0.19	17.13	0.73	14.72	0.20	245.37	48.12		666.21	218.75	188.45
V2001-02-low	53.72	16.43	389.00	384.01	114.83	19.06	23.25	0.34	47.00	2.23	30.41	3.93	19.21	0.16	133.47	20.39	532.68	1035.04	688.25	443.28
V2001-03-low	92.49	30.75	619.31	594.89	177.82	33.56			33.30	2.82	135.12	5.75	17.87	0.38	208.91	36.00		489.19	1789.26	267.11
V2001-04-low	56.73	20.09	405.65	387.47	121.22	27.55	15.70	5.51	31.34	1.13	17.62	0.85	13.83	0.13	140.90	29.33	345.89	672.71	386.76	305.64
V2001-05-low	98.84	21.46	940.35	764.90	208.72	34.02	17.43	2.25	38.05	0.91	15.65	0.23	14.59	0.26	242.87	36.09	224.83	481.04	202.23	188.69
V2001-06	57.35	22.75	468.91	311.26	129.15	68.62	25.78	0.29	22.46	0.72	19.84	0.20	14.81	0.40	149.37	72.26	527.93	462.41	410.07	308.59
V2001-07-low	26.47	8.38	250.24	308.73	85.56	42.09	18.35	0.30	27.73	1.32	18.49	1.00	12.23	0.19	96.19	44.24	581.30	859.28	585.52	393.12
V2001-08-low	79.90	24.54	685.00	581.99	186.67	44.73	21.42	4.19	44.74	3.03	27.06	0.33	18.83	0.19	215.18	47.33	309.77	630.88	388.91	273.07
V2001-09-low	62.98	24.19	500.32	465.23	136.69	43.52	19.62	0.27	25.96	3.62	15.34	0.30	14.73	0.23	158.64	46.06	382.63	501.72	301.05	289.48
V2001-10	98.77	23.25	701.13	448.28	182.83	54.25			30.24	0.74	40.33	0.72	15.13	0.10	215.67	57.23		432.24	570.22	219.81
V2001-11-low	76.71	21.50	558.79	525.18	147.37	44.51	20.65	0.31	30.32	0.30	18.16	0.18	15.82	0.26	173.15	47.02	369.45	535.34	325.95	284.89
V2001-12	75.62	20.90	428.60	402.80	137.51	46.16			29.71	2.26	41.58	15.00	17.51	0.25	162.54	48.73		557.85	768.04	334.58
V2001-13	140.43	62.86	903.11	673.44	265.00	97.22			52.63	2.84	40.56	16.45	20.19	0.24	311.95	103.18		516.63	401.75	203.12
V2001-14-low	56.77	11.92	521.32	507.43	148.19	27.58	20.52	0.29	24.64	0.64	16.53	0.37	17.69	0.30	169.22	29.10	375.34	448.20	304.04	324.89
V2001-15-l	107.03	22.64	763.07	554.99	229.73	52.37			54.06	0.37	34.71	10.10	17.83	0.28	266.91	55.26		615.36	401.75	209.49
V2001-16-core	64.77	20.85	403.01	428.15	129.99	42.10	15.41	10.07	21.90	0.68	16.68	0.32	11.61	0.10	152.04	44.49	315.36	443.53	340.57	238.98
V2001-16-rim-l	103.65	19.20	754.99	569.79	227.90	60.75			21.95	1.93	26.02	0.35	13.40	0.09	264.17	63.95		259.59	306.64	159.75
V2001-17-l	65.36	12.78	438.12	461.88	130.93	32.27	22.03	0.54	26.95	6.80	18.97	0.32	23.16	0.98	153.16	34.02	443.07	537.80	383.33	464.82
V2001-18-l	89.69	33.66	537.51	343.80	172.15	42.99	20.79	0.47	29.34	0.25	18.72	0.32	21.68	0.62	202.28	45.85	319.64	446.53	288.44	332.89
V2001-19	136.59	28.72	820.57	471.11	241.27	49.58	21.82	0.28	31.33	0.29	18.52	0.30	19.54	0.30	286.11	52.52	238.60	339.96	203.07	214.08
V2001-20-l	100.31	18.06	563.22	404.25	181.57	36.98	20.75	0.39	26.41	3.29	19.62	0.35	20.31	0.55	214.73	39.07	300.90	380.57	284.97	294.65
V2001-21-l	68.36	20.19	444.16	358.32	130.63	30.09			32.28	1.79	30.25	0.39	16.29	0.12	153.57	31.97		637.46	599.16	329.51
V2001-22	96.13	22.98	713.64	588.52	203.20	41.87	18.44	3.14	174.13	7.03	14.52	0.22	13.27	0.11	236.43	44.31	243.96	2002.39	192.85	176.45
V2001-23	108.34	33.16	588.48	426.06	170.96	40.68			55.10	0.25	555.70	12.85	20.39	0.20	205.51	43.45		802.63	5474.06	308.71
V2001-24-core	71.76	21.83	466.62	393.80	144.44	34.13	15.89	0.37	27.95	0.77	16.77	0.30	17.72	0.38	168.88	36.21	293.26	507.08	308.99	326.08
V2001-24-rim-l	136.40	34.56	1027.69	726.31	280.19	52.31	24.90	0.12	45.31	0.52	32.30	0.43	24.12	0.29	326.93	55.55	238.34	427.34	307.54	230.97
V2001-25-l	109.82	28.27	777.88	591.14	233.22	55.91	21.70	0.31	31.91	0.33	19.28	0.32	18.60	0.65	271.24	59.10	250.14	364.51	222.70	214.98
V2001-26-l	100.71	22.57	644.80	680.33	212.98	51.35			39.93	2.85	269.38	502.12	17.71	0.19	247.80	54.19		494.28	2773.71	223.86
V2001-27-l	140.97	28.93	968.32	632.45	284.61	61.00	30.11	0.20	46.64	0.83	34.00	0.18	24.08	0.41	332.67	64.43	282.26	432.15	317.85	226.72
V2001-28-l	65.05	29.40	478.72	568.95	146.37	52.16			45.65	2.96	731.67	1.05	20.25	0.25	169.30	55.22		806.96	7372.81	370.52
V2001-29-l	127.27	37.08	698.95	571.80	214.04	70.77			49.99	1.38	295.57	7.38	24.15	0.08	255.29	74.84		595.85	2918.81	294.73
V2001-30-l	93.28	37.40	465.34	350.87	171.55	67.96	21.28	0.39	34.81	0.96	22.40	0.37	19.97	0.47	202.51	71.92	326.55	526.00	343.29	306.92
V2001-31-l	55.54	13.49	396.74	480.48	110.71	22.29			38.09	0.68	105.63	202.12	17.68	0.16	129.57	23.63		875.13	2183.87	420.92
V2001-32-l	29.85	7.39	275.92	274.17	76.66	21.57	23.73	0.50	22.14	2.05	17.32	0.31	18.35	0.42	87.66	22.71	809.92	758.90	601.03	635.03
V2001-33-l	66.80	23.46	387.91	402.47	132.42	48.52	19.70	2.92	25.58	0.35	16.69	0.60	14.08	0.13	155.07	51.26	392.80	505.62	334.27	283.15
V2001-34-l	79.26	22.59	529.66	476.01	162.93	59.59	16.37	5.29	33.77	1.05	17.73	0.36	14.92	0.12	190.10	62.80	268.85	542.82	290.75	245.53
V2001-35	171.35	39.45	765.73	484.65	255.33	60.88			51.67	3.08	184.13	379.24	22.29	0.26	309.22	64.62		511.81	1664.00	225.84
V2001-01-high	117.97	29.75	779.08	440.24	219.64	63.39			54.02	0.19	17.13	0.73	14.72	0.20	258.93	66.94		632.98	207.48	178.72
V2001-02-high	211.38	62.32	876.38	532.48	263.11	86.89	23.25	0.34	47.00	2.23	30.41	3.93	19.21	0.16	327.00	92.46	222.76	442.70	289.84	184.62
V2001-03-high	106.40	20.91	763.74	513.74	210.17	54.73			33.30	2.82	135.12	5.75	17.87	0.38	246.22	57.69		417.40	1548.02	227.34
V2001-04-high	69.33	33.76	429.83	472.27	128.51	49.17	15.70	5.51	31.34	1.13	17.62	0.85	13.83	0.13	151.58	52.26	322.11	627.53	360.25	284.57
V2001-05-high	79.16	29.20	697.95	569.09	196.15	51.60	17.43	2.25	38.05	0.91	15.65	0.23	14.59	0.26	224.96	54.63	242.41	517.85	218.07	203.48
V2001-06	57.35	22.75	468.91	311.26	129.15	68.62	25.78	0.29	22.46	0.72	19.84	0.20	14.81	0.40	149.37	72.26	527.93	462.41	410.07	308.59
V2001-07-high	125.79	29.47	669.78	480.58	192.81	64.10	18.35	0.30	27.73	1.32	18.49	1.00	12.23	0.19	232.64	67.67	246.73	369.25	248.56	165.45
V2001-08-high	151.23	41.22	819.85	352.64	243.09	58.05	21.42	4.19	44.74	3.03	27.06	0.33	18.83	0.19	291.54	61.75	230.06	471.51	289.28	202.65
V2001-09-high	74.80	16.27	481.45	387.56	138.10	23.51	19.62	0.27	25.96	3.62	15.34	0.30	14.73	0.23	162.96	24.99	372.78	488.92	293.25	281.97
V2001-10	98.77	23.25	701.13	448.28	182.83	54.25			30.24	0.74	40.33	0.72	15.13	0.10	215.67	57.23		432.24	570.22	219.81
V2001-11-high	87.67	32.37	599.33	418.35	174.09	40.31	20.65	0.31	30.32	0.30	18.16	0.18	15.82	0.26	203.84	43.03	315.17	457.54	277.93	242.80
V2001-12	75.62	20.90	428.60	402.80	137.51	46.16			29.71	2.26	41.58	15.00	17.51	0.25	162.54	48.73		557.85	768.04	334.58
V2001-13	140.43	62.86	903.11	673.44	265.00	97.22			52.63	2.84	40.56	16.45	20.19	0.24	311.95	103.18		516.63	401.75	203.12
V2001-14-high	81.72	26.52	732.05	397.19	210.67	57.81	20.52	0.29	24.64	0.64	16.53	0.37	17.69	0.30	240.82	61.03	266.01	318.17	215.13	230.00
V2001-15-h	128.66	30.09	805.88	481.82	259.01	77.11			54.06	0.37	34.71	10.10	17.83	0.28	302.84	81.28		545.35	355.38	184.99
V2001-16-core	64.77	20.85	403.01	428.15	129.99	42.10	15.41	10.07	21.90	0.68	16.68	0.32	11.61	0.10	152.04	44.49	315.36	443.53	340.57	238.98
V2001-16-rim-h	79.31	25.17	722.18	514.41	204.08	55.99			21.95	1.93	26.02	0.35	13.40	0.09	233.32	59.10		293.32	346.12	180.58
V2001-17-h	136.65	48.60	709.48	431.42	215.99	57.24	22.03	0.54	26.95	6.80	18.97	0.32	23.16	0.98	259.58	61.23	265.09	322.71	228.92	278.29
V2001-18-h	243.32	37.97	1080.20	610.26	335.87	62.46	20.79	0.47	29.34	0.25	18.72	0.32	21.68	0.62	411.					

Spot	$\omega 1^1$	$\omega 1\ 2SD^1$	$\Gamma 1^1$	$\Gamma 1\ 2SD^1$	$\omega 2^1$	$\omega 2\ 2SD^1$	$\Gamma 2^1$	$\Gamma 2\ 2SD^1$	$\omega 3^1$	$\omega 3\ 2SD^1$	$\Gamma 3^1$	$\Gamma 3\ 2SD^1$	ωR^1	$\omega R\ 2SD^1$	ΓR^1	$\Gamma R\ 2SD^1$
DC0661-01	970.97	0.00	4.95	0.08	436.07	0.00	9.37	0.59	1003.03	0.00	6.16	0.12	353.96	0.00	7.50	0.36
DC0661-02	970.19	1.28	6.11	1.73	436.85	0.00	10.96	1.69	1003.03	1.28	7.30	1.77	352.00	0.90	8.14	1.55
DC0661-03	971.16	0.78	4.25	0.84	437.05	0.78	9.41	1.28	1004.59	0.00	4.83	1.23	353.18	0.00	7.06	1.27
DC0661-04-l	971.36	0.90	4.82	0.84	437.05	0.78	9.00	0.85	1004.59	0.00	5.34	0.65	353.37	0.78	6.83	0.47
DC0661-05-l	971.55	0.78	4.36	1.24	437.44	0.59	9.33	2.91	1004.79	1.50	5.13	1.59	353.76	0.78	7.16	1.58
DC0661-06-l	971.75	0.00	4.46	0.47	437.63	0.00	9.34	1.20	1004.79	0.78	5.05	0.73	353.76	0.78	7.44	1.38
DC0661-07-l	971.75	0.00	4.21	0.47	437.63	0.00	8.50	0.50	1005.02	0.69	4.81	0.36	353.96	0.00	6.59	0.27
DC0661-08-l	971.75	0.00	4.05	0.08	436.85	0.00	8.51	0.19	1004.59	0.00	4.04	0.04	353.96	0.00	6.23	0.06
DC0661-09-l	971.75	0.00	4.69	0.79	439.90	1.31	12.75	1.67	1004.59	0.00	5.70	0.43	353.57	0.90	7.29	0.72
DC0661-10-l	971.75	0.00	4.04	0.86	437.63	0.00	9.93	0.10	1004.59	0.00	5.19	0.21	353.96	0.00	6.81	0.10
DC0661-11-l	972.53	0.00	3.79	0.23	437.63	0.00	7.67	1.56	1005.96	0.78	4.07	0.15	353.96	0.00	5.76	0.26
DC0661-12-l					437.83	0.78	12.13	2.38	1004.59	0.00	5.79	1.10	353.57	0.90	7.65	0.78
DC0661-13-l	971.32	0.82	4.97	0.57	437.63	0.00	10.38	0.74	1004.40	0.78	5.51	0.51	353.18	0.00	7.90	0.86
DC0661-14-l	971.75	0.00	4.04	0.31	437.63	1.28	10.36	2.72	1004.59	0.00	5.36	1.52	353.53	0.69	7.00	1.13
DC0661-15-l	971.95	0.78	4.61	0.75	437.52	0.47	8.76	0.81	1005.18	0.78	5.16	0.99	353.76	0.78	7.29	0.92
DC0661-16-l	971.75	0.00	4.25	0.34	437.63	0.00	8.97	0.74	1005.38	0.00	5.04	0.52	353.96	0.00	6.61	0.50
DC0661-17					437.09	0.74	8.29	0.35	1005.57	0.78	4.62	1.03	354.39	0.82	5.79	0.22
DC0661-18					437.20	0.53	8.01	1.40	1005.96	0.78	6.32	1.66	353.96	0.00	5.98	0.28
DC0661-19-l					437.05	0.78	9.31	1.76	1005.18	0.47	4.60	2.51	353.96	0.00	6.19	0.36
DC0661-20-l	971.55	0.78	4.44	0.80	437.63	0.00	10.71	1.18	1004.79	0.78	5.26	0.70	353.37	0.78	7.09	0.79
DC0661-21					437.24	0.65	8.66	1.24	1005.57	0.78	5.62	2.99	353.96	0.00	6.26	0.52
DC0661-22					440.80	0.16	14.96	0.94	1004.01	0.78	7.29	0.60	353.18	0.00	8.88	0.18
DC0661-23-l	971.95	0.78	4.11	0.49	437.63	0.00	9.49	0.74	1005.38	0.00	5.00	0.45	354.15	0.78	6.56	0.05
DC0661-24-l	971.52	0.74	4.59	1.02	438.03	0.90	11.62	3.80	1004.40	0.78	5.79	2.34	353.57	0.90	8.10	3.25
DC0661-25	971.95	0.78	4.39	0.20	437.63	0.00	9.06	0.75	1005.38	0.00	4.87	0.29	353.96	0.00	6.59	0.16
DC0661-26	972.34	0.78	4.16	1.27	437.83	0.78	8.37	2.15	1005.38	1.28	4.74	1.30	354.15	1.50	6.55	1.59
DC0661-27-l	970.97	0.00	5.08	0.26	436.85	0.00	9.69	1.22	1004.59	0.00	5.96	0.42	353.76	0.78	7.67	0.67
DC0661-28	971.75	0.00	4.36	0.29	437.63	0.00	9.52	1.18	1004.79	0.78	5.23	0.88	353.96	0.00	6.77	0.86
DC0661-29-l	971.36	0.90	4.58	0.71	437.05	0.78	9.52	1.56	1004.59	0.00	5.54	1.48	353.76	0.78	7.36	1.16
DC0661-30-l	971.59	0.63	3.39	0.70	438.22	0.78	11.87	3.21	1004.59	0.00	4.98	0.78	353.76	0.78	7.14	0.78
DC0661-31-l					437.63	1.02	11.80	2.70	1004.59	0.00	5.47	0.40	353.37	0.78	7.29	1.03
DC0661-32	971.40	0.82	4.61	0.78	437.24	0.90	9.58	1.18	1004.40	0.78	5.34	0.74	353.57	0.90	6.75	0.63
DC0661-01	970.97	0.00	4.95	0.08	436.07	0.00	9.37	0.59	1003.03	0.00	6.16	0.12	353.96	0.00	7.50	0.36
DC0661-02	970.19	1.28	6.11	1.73	436.85	0.00	10.96	1.69	1003.03	1.28	7.30	1.77	352.00	0.90	8.14	1.55
DC0661-03	971.16	0.78	4.25	0.84	437.05	0.78	9.41	1.28	1004.59	0.00	4.83	1.23	353.18	0.00	7.06	1.27
DC0661-04-h	971.36	0.90	4.82	0.84	437.05	0.78	9.00	0.85	1004.59	0.00	5.34	0.65	353.37	0.78	6.83	0.47
DC0661-05-h	971.55	0.78	4.36	1.24	437.44	0.59	9.33	2.91	1004.79	1.50	5.13	1.59	353.76	0.78	7.16	1.58
DC0661-06-h	971.75	0.00	4.46	0.47	437.63	0.00	9.34	1.20	1004.79	0.78	5.05	0.73	353.76	0.78	7.44	1.38
DC0661-07-h	971.75	0.00	4.21	0.47	437.63	0.00	8.50	0.50	1005.02	0.69	4.81	0.36	353.96	0.00	6.59	0.27
DC0661-08-h	971.75	0.00	4.05	0.08	436.85	0.00	8.51	0.19	1004.59	0.00	4.04	0.04	353.96	0.00	6.23	0.06
DC0661-09-h	971.75	0.00	4.69	0.79	439.90	1.31	12.75	1.67	1004.59	0.00	5.70	0.43	353.57	0.90	7.29	0.72
DC0661-10-h	971.75	0.00	4.04	0.86	437.63	0.00	9.93	0.10	1004.59	0.00	5.19	0.21	353.96	0.00	6.81	0.10
DC0661-11-h	972.53	0.00	3.79	0.23	437.63	0.00	7.67	1.56	1005.96	0.78	4.07	0.15	353.96	0.00	5.76	0.26
DC0661-12-h					437.83	0.78	12.13	2.38	1004.59	0.00	5.79	1.10	353.57	0.90	7.65	0.78
DC0661-13-h	971.32	0.82	4.97	0.57	437.63	0.00	10.38	0.74	1004.40	0.78	5.51	0.51	353.18	0.00	7.90	0.86
DC0661-14-h	971.75	0.00	4.04	0.31	437.63	1.28	10.36	2.72	1004.59	0.00	5.36	1.52	353.53	0.69	7.00	1.13
DC0661-15-h	971.95	0.78	4.61	0.75	437.52	0.47	8.76	0.81	1005.18	0.78	5.16	0.99	353.76	0.78	7.29	0.92
DC0661-16-h	971.75	0.00	4.25	0.34	437.63	0.00	8.97	0.74	1005.38	0.00	5.04	0.52	353.96	0.00	6.61	0.50
DC0661-17					437.09	0.74	8.29	0.35	1005.57	0.78	4.62	1.03	354.39	0.82	5.79	0.22
DC0661-18					437.20	0.53	8.01	1.40	1005.96	0.78	6.32	1.66	353.96	0.00	5.98	0.28
DC0661-19-h					437.05	0.78	9.31	1.76	1005.18	0.47	4.60	2.51	353.96	0.00	6.19	0.36
DC0661-20-h	971.55	0.78	4.44	0.80	437.63	0.00	10.71	1.18	1004.79	0.78	5.26	0.70	353.37	0.78	7.09	0.79
DC0661-21					437.24	0.65	8.66	1.24	1005.57	0.78	5.62	2.99	353.96	0.00	6.26	0.52
DC0661-22					440.80	0.16	14.96	0.94	1004.01	0.78	7.29	0.60	353.18	0.00	8.88	0.18
DC0661-23-h	971.95	0.78	4.11	0.49	437.63	0.00	9.49	0.74	1005.38	0.00	5.00	0.45	354.15	0.78	6.56	0.05
DC0661-24-h	971.52	0.74	4.59	1.02	438.03	0.90	11.62	3.80	1004.40	0.78	5.79	2.34	353.57	0.90	8.10	3.25
DC0661-25	971.95	0.78	4.39	0.20	437.63	0.00	9.06	0.75	1005.38	0.00	4.87	0.29	353.96	0.00	6.59	0.16
DC0661-26	972.34	0.78	4.16	1.27	437.83	0.78	8.37	2.15	1005.38	1.28	4.74	1.30	354.15	1.50	6.55	1.59
DC0661-27-h	970.97	0.00	5.08	0.26	436.85	0.00	9.69	1.22	1004.59	0.00	5.96	0.42	353.76	0.78	7.67	0.67
DC0661-28	971.75	0.00	4.36	0.29	437.63	0.00	9.52	1.18	1004.79	0.78	5.23	0.88	353.96	0.00	6.77	0.86
DC0661-29-h	971.36	0.90	4.58	0.71	437.05	0.78	9.52	1.56	1004.59	0.00	5.54	1.48	353.76	0.78	7.36	1.16
DC0661-30-h	971.59	0.63	3.39	0.70	438.22	0.78	11.87	3.21	1004.59	0.00	4.98	0.78	353.76	0.78	7.14	0.78
DC0661-31-h					437.63	1.02	11.80	2.70	1004.59	0.00	5.47	0.40	353.37	0.78	7.29	1.03
DC0661-32	971.40	0.82	4.61	0.78	437.24	0.90	9.58	1.18	1004.40	0.78	5.34	0.74	353.57	0.90	6.75	0.63

Spot	Th232 (ppm)	Th232 2SD ²	U235 (ppm)	U235 2SD ²	U238 (ppm)	U238 2SD ²	D1 (10 ¹⁶ α/g) ³	D1 2SD ³	D2 (10 ¹⁶ α/g) ³	D2 2SD ³	D3 (10 ¹⁶ α/g) ³	D3 2SD ³	Der (10 ¹⁶ α/g) ³	Der 2SD ³	eU (ppm)	eU 2SD ²	Date1 (Ma) ⁴	Date2 (Ma) ⁴	Date3 (Ma) ⁴	DateER (Ma) ⁴
DC0661-01	931.48	174.01	3489.76	1187.17	1370.04	219.84	28.87	0.78	29.88	4.21	29.78	1.08	20.40	2.11	1662.09	234.58	55.14	57.06	56.86	39.01
DC0661-02	825.75	717.47	3832.94	2743.43	1477.30	1173.59	39.67	16.16	41.13	11.99	40.06	15.94	24.15	9.07	1749.35	1244.24	71.89	74.52	72.58	43.86
DC0661-03	118.34	40.39	849.01	376.24	300.66	64.78	22.28	7.83	30.14	9.10	17.84	11.12	17.83	7.43	344.09	68.71	203.19	273.38	163.24	163.12
DC0661-04-l	128.58	25.26	1021.56	646.24	338.77	61.49	27.58	7.89	27.25	6.06	22.44	5.89	16.51	2.76	386.57	64.85	223.56	220.90	182.48	134.71
DC0661-05-l	117.60	25.50	888.86	493.62	321.58	52.11	23.31	11.55	29.59	20.65	20.51	14.31	18.41	9.25	365.88	55.06	199.95	252.83	176.27	158.49
DC0661-06-l	89.80	29.08	689.44	613.63	240.73	38.74	24.25	4.43	29.62	8.51	19.84	6.57	20.08	8.04	274.32	41.28	275.78	335.35	226.54	229.28
DC0661-07-l	73.34	19.77	509.82	355.63	197.74	41.50	21.93	4.35	23.68	3.52	17.64	3.29	15.09	1.59	225.23	43.83	303.13	326.80	245.03	210.19
DC0661-08-l	70.35	23.08	574.01	398.09	197.09	45.33	20.42	0.76	23.74	1.32	10.73	0.38	12.96	0.34	223.83	47.92	284.41	329.52	151.01	181.99
DC0661-09-l	138.55	39.12	1000.58	579.93	340.00	62.26	26.40	7.43	53.83	11.81	25.71	3.87	19.20	4.19	390.26	66.05	212.14	425.35	206.65	154.95
DC0661-10-l	73.32	22.95	577.13	403.43	181.69	20.23	20.33	7.99	33.84	0.74	21.10	1.92	16.37	0.56	208.37	21.94	303.84	497.95	315.03	245.78
DC0661-11-l	31.92	5.63	326.86	325.01	102.45	19.17	18.01	2.16	17.79	11.04	10.98	1.34	10.24	1.51	115.24	20.18	479.96	474.26	296.72	277.19
DC0661-12-l	229.52	72.37	1303.72	687.07	454.65	94.26			49.41	16.89	26.47	9.94	21.28	4.54	532.46	100.48		289.23	156.59	126.18
DC0661-13-l	159.34	42.71	1122.81	894.78	395.17	96.88	29.07	5.35	37.03	5.28	23.97	4.58	22.73	5.04	453.17	102.24	201.31	255.37	166.48	157.91
DC0661-14-l	150.77	53.13	961.45	586.14	349.91	115.43	20.32	2.93	36.85	19.26	22.64	13.67	17.47	6.61	403.59	121.87	158.57	284.73	176.39	136.56
DC0661-15-l	140.55	32.60	975.61	423.04	355.33	102.91	25.65	6.98	25.57	5.74	20.83	8.93	19.16	5.37	406.83	108.34	197.95	197.29	161.22	148.44
DC0661-16-l	122.12	31.56	889.42	616.46	304.11	73.68	22.31	3.16	27.00	5.22	19.73	4.65	15.22	2.92	348.62	77.73	200.82	242.26	177.96	137.69
DC0661-17	51.40	23.03	554.18	413.84	200.26	37.11			22.21	2.51	15.90	9.29	10.38	1.31	222.61	39.36		310.48	223.80	147.00
DC0661-18	46.00	11.00	266.25	278.71	104.26	39.89			20.21	9.91	31.28	14.92	11.50	1.62	120.51	41.97		513.66	778.62	297.25
DC0661-19-l	79.29	39.73	684.95	380.41	246.43	66.63			29.42	12.52	15.78	22.60	12.77	2.11	277.78	70.60		329.07	178.56	144.89
DC0661-20-l	192.96	41.65	1318.71	585.41	469.05	104.68	24.10	7.46	39.37	8.34	21.67	6.31	18.02	4.63	538.81	110.37	141.02	228.81	126.95	105.76
DC0661-21	73.69	15.33	564.82	436.58	228.28	51.88			24.79	8.78	24.96	26.92	13.18	3.02	257.38	54.59		299.98	301.99	161.22
DC0661-22	238.63	69.81	1550.32	604.23	619.85	115.62			69.50	6.66	40.01	5.43	28.46	1.06	708.12	122.55		305.55	177.67	126.88
DC0661-23-l	68.43	23.27	485.02	331.57	189.41	33.47	20.94	4.60	30.74	5.24	19.34	4.10	14.91	0.28	215.30	35.59	302.89	439.81	280.25	217.10
DC0661-24-l	68.91	30.40	640.15	477.30	230.08	81.43	25.52	9.52	45.85	26.93	26.50	21.08	23.94	19.01	258.12	85.82	307.70	542.75	319.27	289.08
DC0661-25	143.32	40.22	1109.60	703.50	427.06	137.61	23.62	1.91	27.63	5.31	18.16	2.59	15.12	0.94	482.81	144.81	154.13	179.92	118.81	99.04
DC0661-26	102.20	21.13	733.20	470.59	284.47	70.26	21.44	11.88	22.77	15.23	16.99	11.67	14.84	9.28	323.22	73.95	208.08	220.78	165.43	144.72
DC0661-27-l	189.37	35.17	881.35	383.10	370.54	67.56	30.03	2.42	32.13	8.63	28.03	3.80	21.42	3.91	434.52	71.44	216.64	231.49	202.44	155.27
DC0661-28	183.98	95.95	994.13	527.29	376.37	136.44	23.34	2.72	30.95	8.35	21.40	7.94	16.12	5.01	439.34	145.10	167.16	220.75	153.47	115.90
DC0661-29-l	111.68	21.27	879.92	503.54	330.28	66.80	25.40	6.62	30.94	11.10	24.27	13.35	19.61	6.79	373.60	70.33	213.21	258.73	203.82	165.20
DC0661-30-l	128.43	49.32	700.75	503.51	268.85	74.16	14.29	6.54	47.60	22.79	19.21	7.04	18.27	4.59	313.11	78.77	143.91	467.26	192.72	183.43
DC0661-31-l	124.69	43.45	883.96	552.32	340.66	82.64			47.10	19.14	23.58	3.64	19.15	6.05	387.62	87.39		376.16	191.04	155.63
DC0661-32	163.63	93.45	872.77	547.02	369.55	132.87	25.66	7.28	31.34	8.39	22.47	6.66	16.00	3.67	427.30	141.30	188.63	229.67	165.51	118.27
DC0661-01	931.48	174.01	3489.76	1187.17	1370.04	219.84	28.87	0.78	29.88	4.21	29.78	1.08	20.40	2.11	1662.09	234.58	55.14	57.06	56.86	39.01
DC0661-02	825.75	717.47	3832.94	2743.43	1477.30	1173.59	39.67	16.16	41.13	11.99	40.06	15.94	24.15	9.07	1749.35	1244.24	71.89	74.52	72.58	43.86
DC0661-03	118.34	40.39	849.01	376.24	300.66	64.78	22.28	7.83	30.14	9.10	17.84	11.12	17.83	7.43	344.09	68.71	203.19	273.38	163.24	163.12
DC0661-04-h	299.73	62.16	1649.66	667.49	556.96	127.78	27.58	7.89	27.25	6.06	22.44	5.89	16.51	2.76	656.75	135.00	132.53	130.94	108.04	79.63
DC0661-05-h	252.40	112.55	1317.82	511.27	450.02	74.49	23.31	11.55	29.59	20.65	20.51	14.31	18.41	9.25	533.10	82.75	137.89	174.59	121.50	109.19
DC0661-06-h	154.95	82.52	1149.72	557.51	401.94	120.28	24.25	4.43	29.62	8.51	19.84	6.57	20.08	8.04	459.22	127.83	166.15	202.41	136.28	137.94
DC0661-07-h	71.21	21.57	673.73	416.30	235.08	62.90	21.93	4.35	23.68	3.52	17.64	3.29	15.09	1.59	263.92	66.24	259.57	279.91	209.68	179.80
DC0661-08-h	193.25	63.77	1005.36	558.73	391.22	110.68	20.42	0.76	23.74	1.32	10.73	0.38	12.96	0.34	457.16	117.21	140.81	163.44	74.38	89.75
DC0661-09-h	157.04	39.86	988.28	549.13	349.06	67.49	26.40	7.43	53.83	11.81	25.71	3.87	19.20	4.19	404.20	71.50	204.94	411.13	199.63	149.66
DC0661-10-h	146.45	32.42	1018.93	400.91	374.94	59.38	20.33	7.99	33.84	0.74	21.10	1.92	16.37	0.56	428.84	62.83	149.42	246.76	154.99	120.59
DC0661-11-h	33.88	10.06	276.01	275.11	95.78	20.95	18.01	2.16	17.79	11.04	10.98	1.34	10.24	1.51	108.70	22.13	507.70	501.68	314.12	293.48
DC0661-12-h	184.02	43.77	1216.46	492.16	429.54	79.30			49.41	16.89	26.47	9.94	21.28	4.54	495.19	83.92		310.49	168.23	135.58
DC0661-13-h	265.61	47.39	1408.75	557.40	523.57	117.39	29.07	5.35	37.03	5.28	23.97	4.58	22.73	5.04	613.50	123.78	149.30	189.60	123.39	117.02
DC0661-14-h	174.48	49.06	1063.21	528.63	361.17	70.37	20.32	2.93	36.85	19.26	22.64	13.67	17.47	6.61	421.10	74.82	152.05	273.14	169.16	130.94
DC0661-15-h	204.86	45.39	1020.23	447.19	412.45	106.02	25.65	6.98	25.57	5.74	20.83	8.93	19.16	5.37	482.24	111.85	167.40	166.83	136.28	125.46
DC0661-16-h	90.45	16.66	672.57	304.01	258.69	51.94	22.31	3.16	27.00	5.22	19.73	4.65	15.22	2.92	293.34	54.68	237.98	286.92	210.96	163.32
DC0661-17	51.40	23.03	554.18	413.84	200.26	37.11			22.21	2.51	15.90	9.29	10.38	1.31	222.61	39.36		310.48	223.80	147.00
DC0661-18	46.00	11.00	266.25	278.71	104.26	39.89			20.21	9.91	31.28	14.92	11.50	1.62	120.51	41.97		513.66	778.62	297.25
DC0661-19-h	175.93	52.07	989.95	590.05	399.73	111.47			29.42	12.52	15.78	22.60	12.77	2.11	461.94	117.71		199.88	107.96	87.51
DC0661-20-h	306.57	73.92	1480.01	660.26	583.48	150.20	24.10	7.46	39.37	8.34	21.67	6.31	18.02	4.63	686.22	158.70	110.99	180.34	99.89	83.19
DC0661-21	73.69	15.33	564.82	436.58	228.28	51.88			24.79	8.78	24.96	26.92	13.18	3.02	257.38	54.59		299.98	301.99	161.22
DC0661-22	238.63	69.81	1550.32	604.23	619.85	115.62			69.50	6.66	40.01	5.43	28.46	1.06	708.12	122.55		305.55	177.67	126.88
DC0661-23-h	200.64	52.09	1087.28	66																

Spot	$\omega 1^1$	$\omega 1\ 2SD^1$	$\Gamma 1^1$	$\Gamma 1\ 2SD^1$	$\omega 2^1$	$\omega 2\ 2SD^1$	$\Gamma 2^1$	$\Gamma 2\ 2SD^1$	$\omega 3^1$	$\omega 3\ 2SD^1$	$\Gamma 3^1$	$\Gamma 3\ 2SD^1$	ωR^1	$\omega R\ 2SD^1$	ΓR^1	$\Gamma R\ 2SD^1$
DC2101-01-l	974.10	0.00	3.00	0.19	439.20	0.00	6.08	0.23	1007.72	0.00	3.05	0.08	356.30	0.00	4.89	0.03
DC2101-02	974.10	0.00	3.20	0.20	439.00	0.59	6.22	0.21	1007.72	0.00	3.40	0.45	356.30	0.00	5.24	0.39
DC2101-03	974.10	0.00	3.13	0.17	439.16	0.16	6.67	1.39	1007.72	0.00	3.26	0.28	356.30	0.00	5.02	0.19
DC2101-04-l	974.10	0.00	3.01	0.62	439.20	0.00	6.63	0.24	1007.72	0.00	4.08	0.11	356.30	0.00	5.19	0.04
DC2101-05	974.10	0.00	3.33	0.16	439.20	0.00	6.44	0.25	1007.72	0.00	3.98	0.34	355.76	0.74	5.88	0.38
DC2101-06-l	974.10	0.00	3.67	0.12	439.20	0.00	6.59	0.22	1007.72	0.00	3.62	0.27	356.30	0.00	5.32	0.02
DC2101-07-l	974.10	0.00	3.16	0.02	439.20	0.00	6.19	0.33	1007.72	0.00	3.41	0.04	356.30	0.00	5.08	0.08
DC2101-08-l	974.10	0.00	3.20	0.06	439.20	0.00	6.14	0.33	1007.72	0.00	3.56	0.07	356.30	0.00	5.01	0.07
DC2101-09-l	974.25	0.63	3.54	0.11	439.20	0.00	6.72	0.09	1007.72	0.00	3.73	0.12	356.30	0.00	5.00	0.07
DC2101-10	974.25	0.63	3.11	0.41	439.20	0.00	6.40	0.14	1007.72	0.00	3.72	0.13	356.30	0.00	4.98	0.10
DC2101-11	974.10	0.00	3.11	0.05	439.20	0.00	6.15	0.18	1008.04	0.77	3.59	0.07	356.30	0.00	4.97	0.07
DC2101-12	974.10	0.00	3.08	0.04	439.20	0.00	6.06	0.19	1007.88	0.63	3.24	0.12	356.30	0.00	5.01	0.10
DC2101-13-l	974.88	0.00	2.95	0.08	439.20	0.00	6.14	0.37	1007.72	0.00	3.07	0.11	356.30	0.00	4.91	0.12
DC2101-14-l	974.29	0.78	3.29	0.88	439.20	0.00	6.58	1.52	1007.72	0.00	3.32	0.06	356.30	0.00	5.06	0.15
DC2101-15-l	974.64	0.74	3.02	0.48	439.59	0.90	7.79	3.33	1007.92	0.78	3.19	0.51	356.30	0.00	4.94	0.29
DC2101-16	974.29	0.78	3.24	0.26	439.16	0.16	6.27	0.31	1007.53	0.78	3.45	0.48	356.50	0.78	5.21	0.10
DC2101-17-l	974.10	0.00	3.43	0.04	439.20	0.00	7.67	0.13	1007.72	0.00	4.22	0.03	356.30	0.00	5.50	0.08
DC2101-18	974.29	0.78	3.27	0.38	439.20	0.00	6.88	1.28	1007.72	0.00	3.58	0.56	356.30	0.00	5.26	0.46
DC2101-19-l	974.10	0.00	3.20	0.16	439.20	0.00	6.56	0.42	1007.72	0.00	3.58	0.32	356.30	0.00	5.14	0.11
DC2101-20	974.10	0.00	3.12	0.09	440.76	0.00	11.02	0.26	1007.72	0.00	3.48	0.06	356.30	0.00	5.20	0.05
DC2101-21	974.10	0.00	3.53	0.17	439.20	0.00	7.27	0.87	1007.72	0.00	4.27	0.35	356.23	0.31	5.64	0.10
DC2101-22-l	974.10	0.00	3.23	0.11	439.20	0.00	6.55	0.29	1007.72	0.00	3.53	0.45	356.30	0.00	5.33	0.31
DC2101-23-l	974.41	0.77	2.73	0.63	439.20	0.00	7.57	0.61	1007.72	0.00	3.66	0.27	356.30	0.00	5.18	0.12
DC2101-24-l	974.10	0.00	3.19	0.13	439.20	0.00	6.35	0.14	1007.72	0.00	3.54	0.26	356.30	0.00	5.14	0.22
DC2101-25-l	974.88	0.00	3.25	0.09	439.20	0.00	6.14	0.50	1008.50	0.00	3.51	0.10	356.30	0.00	5.03	0.06
DC2101-26	974.10	0.00	3.03	0.03	439.20	0.00	6.34	0.15	1007.72	0.00	3.34	0.10	356.30	0.00	4.96	0.08
DC2101-27-l	974.88	0.00	2.97	0.08	439.20	0.00	6.38	0.43	1007.72	0.00	3.19	0.06	356.30	0.00	4.90	0.05
DC2101-28-l	974.37	0.69	3.05	0.33	439.16	0.16	6.42	0.74	1007.72	0.00	3.30	0.54	356.30	0.00	5.04	0.33
DC2101-29-l	974.10	0.00	3.20	0.16	439.20	0.00	6.23	0.20	1007.72	0.00	3.53	0.23	356.30	0.00	5.10	0.16
DC2101-30	974.88	0.00	3.04	0.16	439.20	0.00	6.18	0.24	1007.72	0.00	3.14	0.14	356.30	0.00	4.92	0.04
DC2101-31-l	974.88	0.00	2.95	0.15	439.20	0.00	6.26	0.12	1007.72	0.00	3.23	0.04	356.30	0.00	4.92	0.08
DC2101-32-l	974.88	0.00	3.20	0.02	439.20	0.00	6.29	0.11	1007.72	0.00	3.40	0.07	356.30	0.00	5.01	0.06
DC2101-01-h	974.10	0.00	3.00	0.19	439.20	0.00	6.08	0.23	1007.72	0.00	3.05	0.08	356.30	0.00	4.89	0.03
DC2101-02	974.10	0.00	3.20	0.20	439.00	0.59	6.22	0.21	1007.72	0.00	3.40	0.45	356.30	0.00	5.24	0.39
DC2101-03	974.10	0.00	3.13	0.17	439.16	0.16	6.67	1.39	1007.72	0.00	3.26	0.28	356.30	0.00	5.02	0.19
DC2101-04-h	974.10	0.00	3.01	0.62	439.20	0.00	6.63	0.24	1007.72	0.00	4.08	0.11	356.30	0.00	5.19	0.04
DC2101-05	974.10	0.00	3.33	0.16	439.20	0.00	6.44	0.25	1007.72	0.00	3.98	0.34	355.76	0.74	5.88	0.38
DC2101-06-h	974.10	0.00	3.67	0.12	439.20	0.00	6.59	0.22	1007.72	0.00	3.62	0.27	356.30	0.00	5.32	0.02
DC2101-07-h	974.10	0.00	3.16	0.02	439.20	0.00	6.19	0.33	1007.72	0.00	3.41	0.04	356.30	0.00	5.08	0.08
DC2101-08-h	974.10	0.00	3.20	0.06	439.20	0.00	6.14	0.33	1007.72	0.00	3.56	0.07	356.30	0.00	5.01	0.07
DC2101-09-h	974.25	0.63	3.54	0.11	439.20	0.00	6.72	0.09	1007.72	0.00	3.73	0.12	356.30	0.00	5.00	0.07
DC2101-10	974.25	0.63	3.11	0.41	439.20	0.00	6.40	0.14	1007.72	0.00	3.72	0.13	356.30	0.00	4.98	0.10
DC2101-11	974.10	0.00	3.11	0.05	439.20	0.00	6.15	0.18	1008.04	0.77	3.59	0.07	356.30	0.00	4.97	0.07
DC2101-12	974.10	0.00	3.08	0.04	439.20	0.00	6.06	0.19	1007.88	0.63	3.24	0.12	356.30	0.00	5.01	0.10
DC2101-13-h	974.88	0.00	2.95	0.08	439.20	0.00	6.14	0.37	1007.72	0.00	3.07	0.11	356.30	0.00	4.91	0.12
DC2101-14-h	974.29	0.78	3.29	0.88	439.20	0.00	6.58	1.52	1007.72	0.00	3.32	0.06	356.30	0.00	5.06	0.15
DC2101-15-h	974.64	0.74	3.02	0.48	439.59	0.90	7.79	3.33	1007.92	0.78	3.19	0.51	356.30	0.00	4.94	0.29
DC2101-16	974.29	0.78	3.24	0.26	439.16	0.16	6.27	0.31	1007.53	0.78	3.45	0.48	356.50	0.78	5.21	0.10
DC2101-17-h	974.10	0.00	3.43	0.04	439.20	0.00	7.67	0.13	1007.72	0.00	4.22	0.03	356.30	0.00	5.50	0.08
DC2101-18	974.29	0.78	3.27	0.38	439.20	0.00	6.88	1.28	1007.72	0.00	3.58	0.56	356.30	0.00	5.26	0.46
DC2101-19-h	974.10	0.00	3.20	0.16	439.20	0.00	6.56	0.42	1007.72	0.00	3.58	0.32	356.30	0.00	5.14	0.11
DC2101-20	974.10	0.00	3.12	0.09	440.76	0.00	11.02	0.26	1007.72	0.00	3.48	0.06	356.30	0.00	5.20	0.05
DC2101-21	974.10	0.00	3.53	0.17	439.20	0.00	7.27	0.87	1007.72	0.00	4.27	0.35	356.23	0.31	5.64	0.10
DC2101-22-h	974.10	0.00	3.23	0.11	439.20	0.00	6.55	0.29	1007.72	0.00	3.53	0.45	356.30	0.00	5.33	0.31
DC2101-23-h	974.41	0.77	2.73	0.63	439.20	0.00	7.57	0.61	1007.72	0.00	3.66	0.27	356.30	0.00	5.18	0.12
DC2101-24-h	974.10	0.00	3.19	0.13	439.20	0.00	6.35	0.14	1007.72	0.00	3.54	0.26	356.30	0.00	5.14	0.22
DC2101-25-h	974.88	0.00	3.25	0.09	439.20	0.00	6.14	0.50	1008.50	0.00	3.51	0.10	356.30	0.00	5.03	0.06
DC2101-26	974.10	0.00	3.03	0.03	439.20	0.00	6.34	0.15	1007.72	0.00	3.34	0.10	356.30	0.00	4.96	0.08
DC2101-27-h	974.88	0.00	2.97	0.08	439.20	0.00	6.38	0.43	1007.72	0.00	3.19	0.06	356.30	0.00	4.90	0.05
DC2101-28-h	974.37	0.69	3.05	0.33	439.16	0.16	6.42	0.74	1007.72	0.00	3.30	0.54	356.30	0.00	5.04	0.33
DC2101-29-h	974.10	0.00	3.20	0.16	439.20	0.00	6.23	0.20	1007.72	0.00	3.53	0.23	356.30	0.00	5.10	0.16
DC2101-30	974.88	0.00	3.04	0.16	439.20	0.00	6.18	0.24	1007.72	0.00	3.14	0.14	356.30	0.00	4.92	0.04
DC2101-31-h	974.88	0.00	2.95	0.15	439.20	0.00	6.26	0.12	1007.72	0.00	3.23	0.04	356.30	0.00	4.92	0.08
DC2101-32-h	974.88	0.00	3.20	0.02	439.20	0.00	6.29	0.11	1007.72	0.00	3.40	0.07	356.30	0.00	5.01	0.06

Spot	Th232 (ppm)	Th232 2SD ²	U235 (ppm)	U235 2SD ²	U238 (ppm)	U238 2SD ²	D1 (10 ⁻⁶ α/g) ³	D1 2SD ³	D2 (10 ⁻⁶ α/g) ³	D2 2SD ³	D3 (10 ⁻⁶ α/g) ³	D3 2SD ³	Der (10 ⁻⁶ α/g) ³	Der 2SD ³	eU (ppm)	eU 2SD ²	Date1 (Ma) ⁴	Date2 (Ma) ⁴	Date3 (Ma) ⁴	DateER (Ma) ⁴
DC2101-01-l	6.70	4.59	51.66	118.81	20.99	11.69	10.63	1.78	6.53	1.64	1.82	0.75	5.14	0.20	23.65	12.33	1294.49	825.21	241.41	657.89
DC2101-02	34.89	26.16	192.89	223.92	73.49	50.83	12.48	1.87	7.48	1.50	4.92	4.05	7.21	2.27	85.54	53.74	449.26	272.98	180.66	263.07
DC2101-03	24.38	23.83	129.70	241.05	50.18	46.00	11.86	1.56	10.73	9.87	3.66	2.52	5.91	1.08	58.54	48.64	615.60	559.28	196.49	314.07
DC2101-04-l	7.43	4.52	94.66	144.79	22.34	7.07	10.71	5.81	10.42	1.69	11.05	0.99	6.88	0.23	25.24	7.50	1227.69	1197.97	1263.56	815.66
DC2101-05	39.23	28.82	200.62	242.02	79.18	55.73	13.68	1.48	9.07	1.75	10.14	3.11	10.94	2.25	92.56	58.92	454.61	305.08	340.02	366.27
DC2101-06-l	53.15	14.47	216.39	280.04	81.63	19.09	16.92	1.13	10.17	1.59	6.89	2.40	7.65	0.13	98.47	20.34	525.83	321.10	219.38	243.06
DC2101-07-l	6.13	3.12	49.73	113.87	19.39	5.82	12.14	0.21	7.31	2.31	5.07	0.34	6.28	0.49	21.83	6.15	1566.22	987.22	701.42	857.46
DC2101-08-l	6.88	2.65	44.65	104.78	27.37	9.38	12.46	0.56	6.98	2.32	6.44	0.66	5.83	0.43	30.39	9.87	1190.68	693.23	642.24	584.17
DC2101-09-l	10.65	4.66	83.43	144.89	34.91	13.08	15.67	1.04	11.04	0.61	7.90	1.08	5.80	0.39	39.21	13.78	1162.45	840.50	612.56	454.92
DC2101-10	14.24	5.08	86.19	151.43	37.10	9.07	11.62	3.85	8.83	1.02	7.82	1.17	5.65	0.57	42.37	9.60	819.84	632.15	563.23	411.44
DC2101-11	16.81	8.43	94.47	129.40	36.25	11.05	11.66	0.47	7.00	1.26	6.69	0.62	5.64	0.39	42.10	11.78	827.26	509.60	487.83	413.43
DC2101-12	14.68	5.88	127.10	179.73	41.81	15.91	11.36	0.33	6.38	1.33	3.50	1.05	5.86	0.60	47.43	16.77	721.46	415.43	230.75	382.45
DC2101-13-l	6.34	3.18	61.54	116.63	21.26	7.44	10.15	0.74	6.98	2.64	1.95	1.01	5.29	0.70	23.85	7.85	1231.95	871.91	256.18	670.70
DC2101-14-l	8.40	4.65	69.79	140.78	28.65	9.74	13.32	8.27	10.07	10.79	4.19	0.54	6.11	0.90	32.09	10.29	1203.86	929.81	403.25	580.15
DC2101-15-l	8.96	3.89	74.83	133.11	25.97	7.62	10.79	4.53	18.65	23.59	3.05	4.60	5.41	1.68	29.42	8.06	1074.42	1757.96	321.94	561.49
DC2101-16	12.46	4.59	98.86	133.98	37.25	15.21	12.84	2.44	7.88	2.22	5.38	4.34	7.02	0.56	42.10	16.01	905.82	570.62	395.25	510.45
DC2101-17-l	13.99	7.09	93.93	117.06	39.28	20.10	14.68	0.35	17.81	0.92	12.37	0.30	8.69	0.46	44.60	21.17	972.43	1161.99	828.94	593.19
DC2101-18	24.52	18.86	134.04	173.41	47.91	25.88	13.18	3.57	12.21	9.05	6.58	5.01	7.29	2.71	56.19	27.55	707.55	658.10	362.75	400.79
DC2101-19-l	35.16	10.42	177.34	176.85	64.93	18.09	12.50	1.52	9.96	3.01	6.56	2.85	6.58	0.65	76.62	19.16	500.28	401.66	267.49	268.25
DC2101-20	19.03	16.41	104.19	160.08	42.73	22.53	11.78	0.79	41.54	1.81	5.71	0.58	6.97	0.28	49.44	23.98	718.22	2240.56	358.37	434.66
DC2101-21	43.28	38.89	231.71	300.39	92.03	63.41	15.56	1.58	14.96	6.20	12.77	3.14	9.51	0.59	107.01	67.23	447.55	430.80	369.49	277.23
DC2101-22-l	10.58	4.73	94.45	147.92	33.07	13.53	12.74	1.00	9.87	2.07	6.10	4.08	7.70	1.84	37.27	14.25	1007.25	793.13	501.81	627.42
DC2101-23-l	36.35	19.70	198.79	309.67	81.06	58.80	8.12	5.88	17.12	4.30	7.31	2.41	6.84	0.72	93.84	61.92	270.23	556.80	243.74	228.40
DC2101-24-l	15.49	9.92	108.48	188.13	38.07	27.27	12.37	1.17	8.46	1.03	6.26	2.35	6.62	1.27	43.70	28.74	844.76	589.64	441.10	465.52
DC2101-25-l	17.11	11.53	103.84	196.51	39.70	21.20	12.97	0.86	6.98	3.54	5.94	0.89	5.94	0.37	45.79	22.44	845.31	468.46	401.04	400.86
DC2101-26	28.74	22.20	167.52	299.23	61.82	55.58	10.85	0.30	8.38	1.08	4.43	0.94	5.58	0.46	71.81	58.60	464.60	361.58	193.57	242.91
DC2101-27-l	12.10	10.39	58.96	120.29	28.13	19.37	10.31	0.77	8.65	3.07	3.08	0.52	5.20	0.30	32.44	20.49	940.92	798.38	295.75	491.80
DC2101-28-l	11.25	9.22	132.58	267.43	36.80	31.38	11.10	3.09	8.90	5.28	4.02	4.89	6.00	1.94	41.34	33.02	803.81	652.20	302.50	447.10
DC2101-29-l	16.33	13.52	77.52	135.08	40.11	25.36	12.52	1.46	7.62	1.43	6.09	2.03	6.37	0.92	46.04	26.82	813.68	507.10	408.21	428.83
DC2101-30	10.69	9.85	115.86	180.36	45.49	35.41	11.00	1.50	7.23	1.69	2.63	1.28	5.31	0.23	50.33	37.25	661.88	442.51	164.18	327.66
DC2101-31-l	5.70	4.10	35.68	89.13	18.61	12.59	10.18	1.41	7.80	0.82	3.39	0.40	5.34	0.46	20.91	13.25	1391.47	1092.20	497.81	766.28
DC2101-32-l	13.55	9.75	76.48	121.91	32.59	24.24	12.53	0.20	8.01	0.80	4.98	0.62	5.86	0.35	37.47	25.56	986.50	648.01	410.77	480.55
DC2101-01-h	13.28	12.19	95.96	181.12	35.14	38.49	10.63	1.78	6.53	1.64	1.82	0.75	5.14	0.20	40.09	40.52	794.65	499.48	143.50	396.17
DC2101-02	34.89	26.16	192.89	223.92	73.49	50.83	12.48	1.87	7.48	1.50	4.92	4.05	7.21	2.27	85.54	53.74	449.26	272.98	180.66	263.07
DC2101-03	24.38	23.83	129.70	241.05	50.18	46.00	11.86	1.56	10.73	9.87	3.66	2.52	5.91	1.08	58.54	48.64	615.60	559.28	196.49	314.07
DC2101-04-h	19.08	6.68	131.09	187.93	46.42	14.38	10.71	5.81	10.42	1.69	11.05	0.99	6.88	0.23	53.32	15.18	610.35	594.89	629.07	399.00
DC2101-05	39.23	28.82	200.62	242.02	79.18	55.73	13.68	1.48	9.07	1.75	10.14	3.11	10.94	2.25	92.56	58.92	454.61	305.08	340.02	366.27
DC2101-06-h	33.11	19.01	289.01	223.49	104.60	42.47	16.92	1.13	10.17	1.59	6.89	2.40	7.65	0.13	117.77	44.83	442.55	269.57	183.94	203.86
DC2101-07-h	12.92	7.01	95.39	185.27	36.40	13.96	12.14	0.21	7.31	2.31	5.07	0.34	6.28	0.49	41.32	14.76	874.55	540.34	380.07	467.19
DC2101-08-h	24.68	8.48	149.30	217.93	57.51	14.47	12.46	0.56	6.98	2.32	6.44	0.66	5.83	0.43	66.31	15.33	572.98	326.93	302.25	274.26
DC2101-09-h	31.38	13.42	164.63	219.52	72.98	22.79	15.67	1.04	11.04	0.61	7.90	1.08	5.80	0.39	84.16	24.15	567.76	405.27	292.66	215.96
DC2101-10	14.24	5.08	86.19	151.43	37.10	9.07	11.62	3.85	8.83	1.02	7.82	1.17	5.65	0.57	42.37	9.60	819.84	632.15	563.23	411.44
DC2101-11	16.81	8.43	94.47	129.40	36.25	11.05	11.66	0.47	7.00	1.26	6.69	0.62	5.64	0.39	42.10	11.78	827.26	509.60	487.83	413.43
DC2101-12	14.68	5.88	127.10	179.73	41.81	15.91	11.36	0.33	6.38	1.33	3.50	1.05	5.86	0.60	47.43	16.77	721.46	415.43	230.75	382.45
DC2101-13-h	7.93	4.62	78.31	153.37	30.10	12.03	10.15	0.74	6.98	2.64	1.95	1.01	5.29	0.70	33.51	12.68	900.27	632.40	183.36	484.40
DC2101-14-h	20.15	5.65	131.58	153.96	51.73	18.36	13.32	8.27	10.07	10.79	4.19	0.54	6.11	0.90	59.16	19.33	680.82	521.00	221.90	321.20
DC2101-15-h	11.49	5.76	118.02	122.89	39.02	16.10	10.79	4.53	18.65	23.59	3.05	4.60	5.41	1.68	43.73	16.96	742.02	1233.48	218.31	383.01
DC2101-16	12.46	4.59	98.86	133.98	37.25	15.21	12.84	2.44	7.88	2.22	5.38	4.34	7.02	0.56	42.10	16.01	905.82	570.62	395.25	510.45
DC2101-17-h	66.56	19.09	288.60	196.01	103.63	21.29	14.68	0.35	17.81	0.92	12.37	0.30	8.69	0.46	124.78	22.82	364.60	439.71	308.63	218.32
DC2101-18	24.52	18.86	134.04	173.41	47.91	25.88	13.18	3.57	12.21	9.05	6.58	5.01	7.29	2.71	56.19	27.55	707.55	658.10	362.75	400.79
DC2101-19-h	30.11	19.15	150.68	199.74	62.96	27.19	12.50	1.52	9.96	3.01	6.56	2.85	6.58	0.65	73.34	28.91	521.78	419.06	279.20	279.99
DC2101-20	19.03	16.41	104.19	160.08	42.73	22.53	11.78	0.79	41.54	1.81	5.71	0.58	6.97	0.28	49.44	23.98	718.22	2240.56	358.37	434.66
DC2101-21	43.28	38.89	231.71	300.39	92.03	63.41	15.56	1.58	14.96	6.20	12.77	3.14	9.51	0.59	107.01	67.23	447.55	430.80	369.49	277.23
DC2101-22-h	57.52	42.34	266.13	229.60	104.74	68.93	12.74	1.00	9.87	2.07	6.10	4.08	7.70	1.84	123.78	73.09	320.14	249.22	155.23	195.40
DC2101-23-h	53.09	46.10	292.76	394.36	106.17	108.25	8.12	5.88	17.12	4.30	7.31	2.41	6.84	0.72	124.22	114.20	205.18	425.00	184.98	173.29
DC2101-24-h	17.94																			

Spot	$\omega 1^1$	$\omega 1\ 2SD^1$	$\Gamma 1^1$	$\Gamma 1\ 2SD^1$	$\omega 2^1$	$\omega 2\ 2SD^1$	$\Gamma 2^1$	$\Gamma 2\ 2SD^1$	$\omega 3^1$	$\omega 3\ 2SD^1$	$\Gamma 3^1$	$\Gamma 3\ 2SD^1$	ωR^1	$\omega R\ 2SD^1$	ΓR^1	$\Gamma R\ 2SD^1$
CS1093-01-l	971.83	1.04	3.85	0.28	437.75	0.47	9.34	1.25	1005.18	0.78	4.99	1.32	353.76	0.78	6.32	0.64
CS1093-02-l					438.18	0.74	10.40	1.64	1005.38		6.97	0.00	354.15	0.78	7.09	0.57
CS1093-03-l					437.83	0.78	9.31	1.40					353.96	0.00	6.13	0.74
CS1093-04-l					438.42	0.00	11.12	0.40	1006.16	0.00	6.11	1.21	353.96	0.00	6.52	0.05
CS1093-05-core-l	961.58		5.67	0.00	438.46	0.16	11.05	1.96	1005.38	0.00	5.58	1.11	353.57	0.90	7.46	0.63
CS1093-05-rim-l					437.79	0.63	9.10	0.95	1005.77	1.11	7.50	6.18	353.96	0.00	6.35	0.64
CS1093-06-l					437.63	0.00	8.16	0.18	1006.16	0.00	6.26	1.11	354.74	0.00	6.25	0.17
CS1093-07-l	971.75	0.00	4.73	1.21	438.22	0.78	10.63	2.51	1004.79	0.78	5.64	1.49	353.37	0.78	7.48	1.53
CS1093-08-core	972.73	0.78	3.08	0.19	439.24	1.06	11.61	1.41	1006.16	0.00	3.76	0.61	354.55	0.78	5.57	0.68
CS1093-08-rim	972.53	0.00	3.87	0.41	442.99	5.16	42.19	61.63	1005.61	0.74	4.62	0.65	353.96	0.00	6.02	0.73
CS1093-09-l					439.67	1.88	17.37	15.26					352.39	0.00	7.93	2.31
CS1093-10-l	971.75	0.00	3.99	0.76	438.22	0.90	10.18	3.53	1005.30	0.31	4.95	2.70	353.76	0.78	6.59	1.08
CS1093-11-l	972.53	0.00	3.77	0.15	437.83	0.78	8.51	1.33	1005.57	0.78	4.64	0.28	353.96	0.00	6.03	0.29
CS1093-12-l	971.75	0.00	4.44	0.55	437.91	0.74	9.65	0.72	1005.38	0.00	5.44	0.73	353.96	0.00	7.59	0.53
CS1093-13-l	971.75	0.00	4.74	0.95	438.38	0.16	12.42	0.61	1004.95	0.82	6.68	1.48	353.96	0.00	7.50	0.35
CS1093-14-l	971.75	0.00	4.27	0.65	437.63	0.00	8.80	2.01	1005.18	0.78	5.08	1.16	353.49	0.77	6.81	1.36
CS1093-15	972.53	0.00	3.90	0.55	438.18	1.16	10.16	3.60	1005.38	0.00	4.63	0.54	353.96	0.00	6.61	0.49
CS1093-16-l	970.19	0.00	5.08	0.04	445.45	0.00	67.89	0.68	1003.03	0.00	8.52	0.21	352.39	0.00	10.12	0.27
CS1093-17-l					437.75	0.30	9.51	1.29					353.96	0.00	6.45	0.50
CS1093-18-l	972.53	0.00	3.38	0.27	437.63	0.00	6.61	0.40	1005.77	0.90	3.39	0.27	353.96	0.00	5.28	0.40
CS1093-19-l	971.75	0.00	4.05	0.35	437.83	0.59	9.64	1.44	1004.99	0.90	4.86	0.80	353.37	0.78	6.90	0.78
CS1093-20	971.75	0.00	4.09	0.23	437.63	0.00	7.93	0.78	1005.38	0.00	4.95	0.44	353.96	0.00	6.82	0.55
CS1093-21-l	971.95	0.78	3.96	0.15	437.63	0.00	8.04	1.24	1005.38	0.00	4.71	0.50	353.76	0.78	6.42	0.80
CS1093-22-l	971.36	0.90	4.92	1.29	437.83	0.78	10.47	2.82	1004.79	0.78	6.30	2.48	352.98	0.78	8.24	1.54
CS1093-23-l	968.27	0.82	8.23	0.28	440.61	5.91	31.93	54.37	1001.86	0.90	11.71	1.30	350.44	0.90	14.28	3.09
CS1093-24-l					438.42	0.00	10.69	0.37					353.96	0.00	6.88	0.41
CS1093-25-l					438.42	0.00	11.56	0.22					353.96	0.00	7.10	0.19
CS1093-26-l	972.14	0.90	4.27	0.52	438.61	0.78	11.19	2.93	1005.57	0.78	5.50	0.51	353.76	0.78	7.26	0.29
CS1093-27-l					437.83	0.78	10.51	2.25					353.96	0.00	6.63	0.32
CS1093-28-l	972.34	0.78	3.70	0.26	438.03	0.74	9.50	0.31	1005.38	0.00	5.01	0.25	353.96	0.00	6.57	0.16
CS1093-29	970.38	1.50	5.38	0.72	438.26	0.36	12.47	2.65	1003.42	0.90	7.34	2.71	352.20	0.78	9.38	2.45
CS1093-30-l	971.75	0.00	4.32	0.33	437.63	0.00	9.15	1.58	1005.18	0.78	5.09	0.80	353.18	0.00	7.37	0.94
CS1093-31-core-l	964.24	7.51	4.61	0.46	438.42	0.00	10.38	1.09	1005.38	0.00	4.98	0.16	353.96	0.00	6.24	0.09
CS1093-31-rim	972.53	0.00	3.84	0.27	438.42	0.00	10.65	1.07	1005.38	0.00	5.08	0.28	353.96	0.00	6.57	0.13
CS1093-32-l					438.42	0.00	12.67	0.21					353.18	0.00	7.92	0.37
CS1093-01-h	971.83	1.04	3.85	0.28	437.75	0.47	9.34	1.25	1005.18	0.78	4.99	1.32	353.76	0.78	6.32	0.64
CS1093-02-h					438.18	0.74	10.40	1.64	1005.38		6.97	0.00	354.15	0.78	7.09	0.57
CS1093-03-h					437.83	0.78	9.31	1.40					353.96	0.00	6.13	0.74
CS1093-04-h					438.42	0.00	11.12	0.40	1006.16	0.00	6.11	1.21	353.96	0.00	6.52	0.05
CS1093-05-core-h	961.58		5.67	0.00	438.46	0.16	11.05	1.96	1005.38	0.00	5.58	1.11	353.57	0.90	7.46	0.63
CS1093-05-rim-h					437.79	0.63	9.10	0.95	1005.77	1.11	7.50	6.18	353.96	0.00	6.35	0.64
CS1093-06-h					437.63	0.00	8.16	0.18	1006.16	0.00	6.26	1.11	354.74	0.00	6.25	0.17
CS1093-07-h	971.75	0.00	4.73	1.21	438.22	0.78	10.63	2.51	1004.79	0.78	5.64	1.49	353.37	0.78	7.48	1.53
CS1093-08-core	972.73	0.78	3.08	0.19	439.24	1.06	11.61	1.41	1006.16	0.00	3.76	0.61	354.55	0.78	5.57	0.68
CS1093-08-rim	972.53	0.00	3.87	0.41	442.99	5.16	42.19	61.63	1005.61	0.74	4.62	0.65	353.96	0.00	6.02	0.73
CS1093-09-h					439.67	1.88	17.37	15.26					352.39	0.00	7.93	2.31
CS1093-10-h	971.75	0.00	3.99	0.76	438.22	0.90	10.18	3.53	1005.30	0.31	4.95	2.70	353.76	0.78	6.59	1.08
CS1093-11-h	972.53	0.00	3.77	0.15	437.83	0.78	8.51	1.33	1005.57	0.78	4.64	0.28	353.96	0.00	6.03	0.29
CS1093-12-h	971.75	0.00	4.44	0.55	437.91	0.74	9.65	0.72	1005.38	0.00	5.44	0.73	353.96	0.00	7.59	0.53
CS1093-13-h	971.75	0.00	4.74	0.95	438.38	0.16	12.42	0.61	1004.95	0.82	6.68	1.48	353.96	0.00	7.50	0.35
CS1093-14-h	971.75	0.00	4.27	0.65	437.63	0.00	8.80	2.01	1005.18	0.78	5.08	1.16	353.49	0.77	6.81	1.36
CS1093-15	972.53	0.00	3.90	0.55	438.18	1.16	10.16	3.60	1005.38	0.00	4.63	0.54	353.96	0.00	6.61	0.49
CS1093-16-h	970.19	0.00	5.08	0.04	445.45	0.00	67.89	0.68	1003.03	0.00	8.52	0.21	352.39	0.00	10.12	0.27
CS1093-17-h					437.75	0.30	9.51	1.29					353.96	0.00	6.45	0.50
CS1093-18-h	972.53	0.00	3.38	0.27	437.63	0.00	6.61	0.40	1005.77	0.90	3.39	0.27	353.96	0.00	5.28	0.40
CS1093-19-h	971.75	0.00	4.05	0.35	437.83	0.59	9.64	1.44	1004.99	0.90	4.86	0.80	353.37	0.78	6.90	0.78
CS1093-20	971.75	0.00	4.09	0.23	437.63	0.00	7.93	0.78	1005.38	0.00	4.95	0.44	353.96	0.00	6.82	0.55
CS1093-21-h	971.95	0.78	3.96	0.15	437.63	0.00	8.04	1.24	1005.38	0.00	4.71	0.50	353.76	0.78	6.42	0.80
CS1093-22-h	971.36	0.90	4.92	1.29	437.83	0.78	10.47	2.82	1004.79	0.78	6.30	2.48	352.98	0.78	8.24	1.54
CS1093-23-h	968.27	0.82	8.23	0.28	440.61	5.91	31.93	54.37	1001.86	0.90	11.71	1.30	350.44	0.90	14.28	3.09
CS1093-24-h					438.42	0.00	10.69	0.37					353.96	0.00	6.88	0.41
CS1093-25-h					438.42	0.00	11.56	0.22					353.96	0.00	7.10	0.19
CS1093-26-h	972.14	0.90	4.27	0.52	438.61	0.78	11.19	2.93	1005.57	0.78	5.50	0.51	353.76	0.78	7.26	0.29
CS1093-27-h					437.83	0.78	10.51	2.25					353.96	0.00	6.63	0.32
CS1093-28-h	972.34	0.78	3.70	0.26	438.03	0.74	9.50	0.31	1005.38	0.00	5.01	0.25	353.96	0.00	6.57	0.16
CS1093-29	970.38	1.50	5.38	0.72	438.26	0.36	12.47	2.65	1003.42	0.90	7.34	2.71	352.20	0.78	9.38	2.45
CS1093-30-h	971.75	0.00	4.32	0.33	437.63	0.00	9.15	1.58	1005.18	0.78	5.09	0.80	353.18	0.00	7.37	0.94
CS1093-31-core-h	964.24	7.51	4.61	0.46	438.42	0.00	10.38	1.09	1005.38	0.00	4.98	0.16	353.96	0.00	6.24	0.09
CS1093-31-rim	972.53	0.00	3.84	0.27	438.42	0.00	10.65	1.07	1005.38	0.00	5.08	0.28	353.96	0.00	6.57	0.13
CS1093-32-h					438.42	0.00	12.67	0.21					353.18	0.00	7.92	0.37

Spot	Th232 (ppm)	Th232 2SD ²	U235 (ppm)	U235 2SD ²	U238 (ppm)	U238 2SD ²	D1 (10 ⁻⁶ α/g) ³	D1 2SD ³	D2 (10 ⁻⁶ α/g) ³	D2 2SD ³	D3 (10 ⁻⁶ α/g) ³	D3 2SD ³	Der (10 ⁻⁶ α/g) ³	Der 2SD ³	eU (ppm)	eU 2SD ²	Date1 (Ma) ⁴	Date2 (Ma) ⁴	Date3 (Ma) ⁴	DateER (Ma) ⁴
CS1093-01-l	46.66	14.28	597.06	571.43	204.17	47.04	18.60	2.65	29.64	8.83	19.30	11.92	13.50	3.74	225.58	49.51	257.66	405.80	267.12	187.95
CS1093-02-l	121.97	21.45	841.29	503.62	301.63	84.12			37.15	11.63	37.08	0.00	18.01	3.34	345.99	88.47		333.49	332.89	163.86
CS1093-03-l	103.42	26.26	944.64	601.79	330.93	86.33			29.40	9.96			12.39	4.32	372.29	90.87		246.99		105.20
CS1093-04-l	135.32	51.40	852.96	534.14	311.08	86.86			42.25	2.87	29.39	10.93	14.68	0.32	359.11	92.03		364.56	255.74	129.01
CS1093-05-core-l	260.94	65.28	1684.86	849.39	587.54	98.77	35.56	0.00	41.80	13.94	24.57	10.00	20.18	3.68	679.54	104.89	164.71	193.16	114.26	93.98
CS1093-05-rim-l	73.44	17.64	692.33	455.42	256.10	62.16			27.95	6.76	41.86	55.72	13.69	3.72	286.53	65.41		303.66	449.72	150.54
CS1093-06-l	39.96	14.77	513.28	281.61	194.89	85.09			21.28	1.30	30.74	10.03	13.09	0.97	214.23	89.42		309.10	441.99	191.84
CS1093-07-l	530.60	142.69	2747.87	1139.07	1002.07	285.90	26.81	11.34	38.78	17.83	25.18	13.42	20.28	8.96	1179.52	302.14	72.05	103.97	67.69	54.59
CS1093-08-core	140.07	51.49	1216.99	657.03	463.13	148.06	11.39	1.78	45.72	10.03	8.15	5.46	9.13	3.97	519.90	155.95	69.49	274.44	49.80	55.75
CS1093-08-rim	135.36	41.17	1237.66	673.09	461.94	128.30	18.70	3.81	262.60	437.07	15.99	5.84	11.77	4.26	517.53	135.07	114.19	1443.40	97.73	72.13
CS1093-09-l	222.34	105.43	1675.48	813.57	627.49	210.50			86.56	108.22			22.94	13.48	712.22	222.47		376.27		101.88
CS1093-10-l	178.14	67.36	1484.65	720.03	536.34	146.61	19.87	7.08	35.57	25.01	18.96	24.30	15.09	6.32	605.91	154.79	103.72	184.47	99.00	78.93
CS1093-11-l	64.89	26.84	696.08	591.07	269.59	86.10	17.85	1.37	23.78	9.42	16.08	2.49	11.79	1.68	298.64	90.64	187.83	248.95	169.44	124.62
CS1093-12-l	93.11	50.50	869.80	487.12	333.17	73.14	24.05	5.13	31.82	5.14	23.33	6.58	20.92	3.08	372.18	77.75	202.75	266.99	196.83	176.74
CS1093-13-l	279.68	127.14	1695.74	843.17	603.79	131.68	26.84	8.91	51.48	4.31	34.48	13.35	20.38	2.04	701.10	141.59	120.91	229.93	154.91	92.02
CS1093-14-l	106.67	47.10	906.49	607.39	308.26	72.73	22.48	6.09	25.83	14.28	20.11	10.46	16.39	7.94	349.28	77.20	202.00	231.54	181.02	147.93
CS1093-15	121.58	55.63	1034.62	682.89	378.38	179.81	19.01	5.17	35.44	25.57	16.02	4.86	15.19	2.84	426.48	189.27	140.52	259.62	118.66	112.55
CS1093-16-l	835.51	400.54	4232.44	2683.75	1493.97	921.83	30.04	0.42	444.92	4.85	51.07	1.86	35.74	1.55	1769.19	972.69	53.90	755.67	91.37	64.09
CS1093-17-l	56.74	33.92	529.50	471.89	196.27	105.82			30.83	9.18			14.28	2.91	219.70	111.41		432.53		203.96
CS1093-18-l	14.38	5.07	195.78	254.96	75.58	25.15	14.18	2.48	10.30	2.85	4.85	2.40	7.41	2.33	82.81	26.44	524.17	384.93	184.05	279.08
CS1093-19-l	214.42	62.29	1650.00	810.86	595.50	196.43	20.44	3.25	31.77	10.24	18.13	7.17	16.89	4.57	676.74	206.79	95.56	147.94	84.83	79.10
CS1093-20	120.05	43.00	1150.73	694.42	384.04	86.18	20.78	2.12	19.67	5.53	18.95	3.96	16.43	3.20	432.05	91.08	151.53	143.52	138.35	120.12
CS1093-21-l	88.54	22.33	789.95	433.32	280.68	69.26	19.60	1.38	20.40	8.78	16.78	4.54	14.10	4.68	315.97	72.92	194.78	202.63	167.08	140.76
CS1093-22-l	644.00	287.41	3101.22	1835.30	1187.48	447.71	28.60	12.04	37.63	20.03	31.04	22.36	24.73	9.00	1401.42	475.13	64.72	85.03	70.24	56.01
CS1093-23-l	1039.18	582.57	3983.45	2162.89	1547.98	789.11	59.46	2.66	189.88	385.57	79.78	11.75	60.05	18.05	1874.78	840.28	100.32	315.05	134.26	101.32
CS1093-24-l	114.73	36.58	929.18	623.47	326.14	83.03			39.21	2.64			16.78	2.40	369.98	87.62		329.32		142.99
CS1093-25-l	158.56	62.74	818.21	741.60	331.94	86.66			45.40	1.55			18.09	1.12	386.60	92.23		363.91		147.49
CS1093-26-l	92.36	24.93	753.59	299.57	287.20	49.11	22.46	4.83	42.74	20.77	23.87	4.62	19.00	1.72	323.73	51.91	217.45	407.70	230.88	184.48
CS1093-27-l	169.97	58.09	1337.11	768.90	497.26	159.95			37.95	15.95			15.34	1.89	562.91	168.52		211.44		86.31
CS1093-28-l	90.62	27.07	575.16	461.51	222.95	61.65	17.15	2.46	30.75	2.20	19.44	2.27	14.97	0.91	255.85	65.06	210.24	372.20	237.77	183.83
CS1093-29	1122.23	310.35	7977.51	2662.24	3095.94	1078.68	32.84	6.76	51.83	18.80	40.42	24.42	31.41	14.33	3520.07	1135.06	29.68	46.77	36.50	28.38
CS1093-30-l	87.86	23.71	954.02	564.24	347.84	62.67	22.94	3.06	28.26	11.18	20.20	7.20	19.68	5.52	386.32	66.05	186.58	229.12	164.57	160.38
CS1093-31-core-l	118.15	98.70	739.45	453.36	291.20	107.83	25.66	4.34	36.99	7.76	19.22	1.46	13.07	0.53	334.11	115.68	240.32	343.63	180.87	123.50
CS1093-31-rim	184.07	119.30	1392.30	711.69	531.46	152.03	18.44	2.53	38.91	7.56	20.11	2.55	14.99	0.74	602.20	162.18	96.90	202.77	105.59	78.86
CS1093-32-l	120.69	45.24	1068.27	606.09	404.12	86.37			53.29	1.47			22.86	2.18	453.29	91.33		364.31		158.80
CS1093-01-h	194.59	56.99	1332.10	627.81	476.97	79.61	18.60	2.65	29.64	8.83	19.30	11.92	13.50	3.74	547.52	84.70	107.41	170.29	111.40	78.10
CS1093-02-h	145.53	34.87	945.57	648.87	348.44	59.36			37.15	11.63	37.08	0.00	18.01	3.34	400.79	62.89		288.90	288.37	141.70
CS1093-03-h	222.01	58.54	1496.92	584.21	614.73	144.47			29.40	9.96			12.39	4.32	698.75	152.34		132.77		56.26
CS1093-04-h	126.10	43.89	959.66	569.03	358.62	102.29			42.25	2.87	29.39	10.93	14.68	0.32	406.81	107.92		322.87	226.28	114.02
CS1093-05-core-l	441.70	113.58	2192.68	779.79	781.79	184.46	35.56	0.00	41.80	13.94	24.57	10.00	20.18	3.68	926.89	195.59	121.16	142.17	83.96	69.04
CS1093-05-rim-h	144.60	47.53	1287.08	745.64	467.95	156.25			27.95	6.76	41.86	55.72	13.69	3.72	526.05	164.46		167.17	248.84	82.43
CS1093-06-h	383.75	253.37	3638.14	2430.20	1356.29	629.65			21.28	1.30	30.74	10.03	13.09	0.97	1516.20	663.92		44.58	64.32	27.45
CS1093-07-h	434.16	90.76	2529.85	907.28	938.94	220.04	26.81	11.34	38.78	17.83	25.18	13.42	20.28	8.96	1090.09	232.06	77.92	112.42	73.21	59.04
CS1093-08-core	140.07	51.49	1216.99	657.03	463.13	148.06	11.39	1.78	45.72	10.03	8.15	5.46	9.13	3.97	519.90	155.95	69.49	274.44	49.80	55.75
CS1093-08-rim	135.36	41.17	1237.66	673.09	461.94	128.30	18.70	3.81	262.60	437.07	15.99	5.84	11.77	4.26	517.53	135.07	114.19	1443.40	97.73	72.13
CS1093-09-h	1324.70	450.59	5142.16	2314.18	1767.44	623.09			86.56	108.22			22.94	13.48	2173.74	663.12		125.72		33.56
CS1093-10-h	351.36	104.01	1973.24	1064.10	709.66	274.57	19.87	7.08	35.57	25.01	18.96	24.30	15.09	6.32	829.47	289.38	75.93	135.27	72.46	57.75
CS1093-11-h	94.96	21.96	957.09	545.23	307.96	136.23	17.85	1.37	23.78	9.42	16.08	2.49	11.79	1.68	346.15	143.14	162.37	215.35	146.45	107.66
CS1093-12-h	212.81	45.43	1912.85	1178.65	713.96	243.77	24.05	5.13	31.82	5.14	23.33	6.58	20.92	3.08	800.73	256.19	95.03	125.47	92.24	82.75
CS1093-13-h	782.75	210.76	5405.87	1703.35	1893.75	412.39	26.84	8.91	51.48	4.31	34.48	13.35	20.38	2.04	2176.30	435.95	39.20	74.97	50.31	29.79
CS1093-14-h	134.34	35.80	1213.75	676.93	460.43	108.01	22.48	6.09	25.83	14.28	20.11	10.46	16.39	7.94	515.70	113.74	137.50	157.72	123.16	100.56
CS1093-15	121.58	55.63	1034.62	682.89	378.38	179.81	19.01	5.17	35.44	25.57	16.02	4.86	15.19	2.84	426.48	189.27	140.52	259.62	118.66	112.55
CS1093-16-h	967.80	499.42	5718.52	3211.76	2086.36	1237.79	30.04	0.42	444.92	4.85	51.07	1.86	35.74	1.55	2422.96	1305.20	39.40	560.33	66.84	46.86
CS1093-17-h	68.42	31.62	893.56	746.07	344.06	142.85			30.83	9.18			14.28	2.91	377.68	150.18		255.12		119.43
CS1093-18-h	135.95	55.27	1259.76	675.81	450.20	139.57	14.18	2.48	10.30	2.85	4.85	2.40	7.41	2.33	505.34	147.15	88.87	64.68	30.52	46.57
CS1093-19-h	272.54	5																		

Spot	$\omega 1^1$	$\omega 1\ 2SD^1$	$\Gamma 1^1$	$\Gamma 1\ 2SD^1$	$\omega 2^1$	$\omega 2\ 2SD^1$	$\Gamma 2^1$	$\Gamma 2\ 2SD^1$	$\omega 3^1$	$\omega 3\ 2SD^1$	$\Gamma 3^1$	$\Gamma 3\ 2SD^1$	ωR^1	$\omega R\ 2SD^1$	ΓR^1	$\Gamma R\ 2SD^1$
DC1002-01-l	972.53	0.00	5.68	1.04	438.81	0.90	11.08	0.71	1005.57	0.78	6.14	0.72	354.58	0.63	7.85	1.04
DC1002-02	973.27	0.16	4.06	0.25	439.32	0.47	11.25	0.73	1006.35	0.78	5.72	0.58	355.13	0.90	6.84	0.29
DC1002-03-l	973.31	0.00	4.14	0.31	438.96	0.74	8.02	0.63	1006.24	0.18	4.70	0.24	355.52	0.00	6.57	0.51
DC1002-04-l	973.31	0.00	3.98	0.15	439.00	0.78	8.19	0.38	1006.94	0.00	4.56	0.48	355.52	0.00	6.48	0.35
DC1002-05-l					439.24	0.16	11.30	1.61					355.52	0.00	6.85	0.10
DC1002-06-l	972.53	0.00	4.87	0.45	440.18	0.78	12.88	1.43	1005.77	0.90	7.15	1.10	354.35	0.90	8.14	0.81
DC1002-07-l	973.51	0.78	3.86	0.73	438.49	0.31	7.57	1.20	1006.74	0.78	4.24	1.44	355.72	0.78	6.13	0.82
DC1002-08-l	973.31	0.00	4.06	0.11	439.71	0.69	10.46	1.40	1006.94	0.00	6.07	1.09	354.74	0.00	7.48	0.64
DC1002-09-core-l	972.73	0.78	4.88	0.45	439.39	0.78	10.79	0.39	1006.71	1.36	11.80	18.79	354.94	0.78	7.86	0.36
DC1002-09-rim-l	972.92	0.90	4.41	0.52	438.89	0.68	9.63	1.56	1006.16	0.00	5.18	0.40	354.98	0.74	6.86	0.47
DC1002-10-l	973.31	0.00	4.25	0.16	439.39	0.78	10.17	1.13	1006.39	0.74	6.62	0.86	355.52	0.00	7.09	0.21
DC1002-11-l	973.12	0.78	4.46	0.71	439.20	0.00	9.28	1.64	1006.35	0.78	5.23	1.42	355.17	0.82	7.28	1.03
DC1002-12-l	973.31	0.00	4.22	0.51	438.77	0.82	8.27	0.99	1006.55	0.90	4.96	0.68	355.52	0.00	6.89	0.61
DC1002-13					438.89	0.68	10.72	2.05	1006.55	1.11	5.60	1.60	355.29	0.74	6.82	0.78
DC1002-14-l	973.31	0.00	3.76	0.50	439.08	0.47	7.86	1.30	1006.94	0.00	4.05	0.48	355.52	0.00	6.43	1.04
DC1002-15-l	973.70	0.90	4.04	0.62	439.20	0.00	9.06	1.48	1007.14	0.78	5.84	0.33	355.72	0.78	6.26	0.56
DC1002-16-l	973.31	0.00	4.25	0.15	440.76	4.77	19.76	33.98	1006.35	0.78	4.93	0.90	355.44	0.31	6.96	0.44
DC1002-17-core-l	972.79	0.90	4.11	1.64	439.78	0.69	13.17	1.57	1005.96	0.78	6.58	1.13	354.74	0.00	7.87	0.48
DC1002-17-rim-l	972.92	1.11	3.27	0.98	439.47	0.64	11.69	2.67	1006.16	0.00	5.61	0.79	355.13	0.90	6.92	0.83
DC1002-18-l	973.12	0.78	4.38	0.21	439.20	0.00	9.11	1.04	1006.35	0.78	4.99	0.71	355.13	0.90	6.87	0.99
DC1002-19	973.31	0.00	3.55	0.80	438.65	0.54	9.16	1.17	1006.59	0.82	4.93	0.81	355.52	0.00	6.29	0.47
DC1002-20	973.31	0.00	3.80	0.86	439.20	0.00	9.03	1.03	1006.74	0.78	4.88	1.42	355.52	0.00	6.07	0.53
DC1002-21	973.04	1.09	5.26	3.60	439.59	0.90	10.90	2.54	1006.51	0.82	6.68	3.05	355.52	0.00	6.92	1.08
DC1002-22-l	973.31	0.00	4.36	0.40	439.35	0.36	10.98	0.29	1006.16	0.00	5.93	0.84	355.52	0.00	6.57	0.19
DC1002-23-l	973.51	0.78	4.52	0.44	439.59	0.90	10.34	1.74	1006.71	0.74	5.23	0.65	355.72	0.78	6.93	0.41
DC1002-24					439.16	0.16	8.92	0.63	1006.94	0.00	5.05	0.59	355.72	0.78	6.51	0.34
DC1002-25-l					439.00	0.78	9.12	2.12	1006.84	0.36	7.34	1.26	355.52	0.00	6.38	0.20
DC1002-26	971.95	1.50	5.77	1.19	439.20	0.00	13.62	3.93	1005.18	0.78	7.05	1.53	354.55	0.78	8.34	2.43
DC1002-27-l	973.12	0.78	4.48	0.82	439.20	0.00	10.01	1.79	1006.35	0.78	5.14	0.70	355.33	0.78	6.84	1.04
DC1002-28-l	973.51	0.78	3.99	0.26	439.20	0.00	10.10	1.07	1006.94	0.00	4.66	0.32	355.91	0.90	6.15	0.31
DC1002-29-l	973.12	0.78	4.23	0.50	439.39	0.78	10.99	0.94	1006.35	0.78	5.29	0.82	355.52	0.00	6.46	0.22
DC1002-30-l	973.31	0.00	4.47	0.32	439.20	0.00	9.52	1.36	1006.63	0.77	5.37	0.45	355.52	0.00	6.86	0.73
DC1002-31	973.51	0.78	4.70	0.78	439.20	0.00	9.01	0.82	1006.35	0.78	5.44	1.21	355.68	0.63	7.37	1.03
DC1002-32	973.12	1.50	4.14	0.20	439.39	0.78	10.14	3.28	1006.35	0.78	5.86	2.03	354.94	1.97	7.57	1.87
DC1002-01-h	972.53	0.00	5.68	1.04	438.81	0.90	11.08	0.71	1005.57	0.78	6.14	0.72	354.58	0.63	7.85	1.04
DC1002-02	973.27	0.16	4.06	0.25	439.32	0.47	11.25	0.73	1006.35	0.78	5.72	0.58	355.13	0.90	6.84	0.29
DC1002-03-h	973.31	0.00	4.14	0.31	438.96	0.74	8.02	0.63	1006.24	0.18	4.70	0.24	355.52	0.00	6.57	0.51
DC1002-04-h	973.31	0.00	3.98	0.15	439.00	0.78	8.19	0.38	1006.94	0.00	4.56	0.48	355.52	0.00	6.48	0.35
DC1002-05-h					439.24	0.16	11.30	1.61					355.52	0.00	6.85	0.10
DC1002-06-h	972.53	0.00	4.87	0.45	440.18	0.78	12.88	1.43	1005.77	0.90	7.15	1.10	354.35	0.90	8.14	0.81
DC1002-07-h	973.51	0.78	3.86	0.73	438.49	0.31	7.57	1.20	1006.74	0.78	4.24	1.44	355.72	0.78	6.13	0.82
DC1002-08-h	973.31	0.00	4.06	0.11	439.71	0.69	10.46	1.40	1006.94	0.00	6.07	1.09	354.74	0.00	7.48	0.64
DC1002-09-core-h	972.73	0.78	4.88	0.45	439.39	0.78	10.79	0.39	1006.71	1.36	11.80	18.79	354.94	0.78	7.86	0.36
DC1002-09-rim-h	972.92	0.90	4.41	0.52	438.89	0.68	9.63	1.56	1006.16	0.00	5.18	0.40	354.98	0.74	6.86	0.47
DC1002-10-h	973.31	0.00	4.25	0.16	439.39	0.78	10.17	1.13	1006.39	0.74	6.62	0.86	355.52	0.00	7.09	0.21
DC1002-11-h	973.12	0.78	4.46	0.71	439.20	0.00	9.28	1.64	1006.35	0.78	5.23	1.42	355.17	0.82	7.28	1.03
DC1002-12-h	973.31	0.00	4.22	0.51	438.77	0.82	8.27	0.99	1006.55	0.90	4.96	0.68	355.52	0.00	6.89	0.61
DC1002-13					438.89	0.68	10.72	2.05	1006.55	1.11	5.60	1.60	355.29	0.74	6.82	0.78
DC1002-14-h	973.31	0.00	3.76	0.50	439.08	0.47	7.86	1.30	1006.94	0.00	4.05	0.48	355.52	0.00	6.43	1.04
DC1002-15-h	973.70	0.90	4.04	0.62	439.20	0.00	9.06	1.48	1007.14	0.78	5.84	0.33	355.72	0.78	6.26	0.56
DC1002-16-h	973.31	0.00	4.25	0.15	440.76	4.77	19.76	33.98	1006.35	0.78	4.93	0.90	355.44	0.31	6.96	0.44
DC1002-17-core-h	972.79	0.90	4.11	1.64	439.78	0.69	13.17	1.57	1005.96	0.78	6.58	1.13	354.74	0.00	7.87	0.48
DC1002-17-rim-h	972.92	1.11	3.27	0.98	439.47	0.64	11.69	2.67	1006.16	0.00	5.61	0.79	355.13	0.90	6.92	0.83
DC1002-18-h	973.12	0.78	4.38	0.21	439.20	0.00	9.11	1.04	1006.35	0.78	4.99	0.71	355.13	0.90	6.87	0.99
DC1002-19	973.31	0.00	3.55	0.80	438.65	0.54	9.16	1.17	1006.59	0.82	4.93	0.81	355.52	0.00	6.29	0.47
DC1002-20	973.31	0.00	3.80	0.86	439.20	0.00	9.03	1.03	1006.74	0.78	4.88	1.42	355.52	0.00	6.07	0.53
DC1002-21	973.04	1.09	5.26	3.60	439.59	0.90	10.90	2.54	1006.51	0.82	6.68	3.05	355.52	0.00	6.92	1.08
DC1002-22-h	973.31	0.00	4.36	0.40	439.35	0.36	10.98	0.29	1006.16	0.00	5.93	0.84	355.52	0.00	6.57	0.19
DC1002-23-h	973.51	0.78	4.52	0.44	439.59	0.90	10.34	1.74	1006.71	0.74	5.23	0.65	355.72	0.78	6.93	0.41
DC1002-24					439.16	0.16	8.92	0.63	1006.94	0.00	5.05	0.59	355.72	0.78	6.51	0.34
DC1002-25-h					439.00	0.78	9.12	2.12	1006.84	0.36	7.34	1.26	355.52	0.00	6.38	0.20
DC1002-26	971.95	1.50	5.77	1.19	439.20	0.00	13.62	3.93	1005.18	0.78	7.05	1.53	354.55	0.78	8.34	2.43
DC1002-27-h	973.12	0.78	4.48	0.82	439.20	0.00	10.01	1.79	1006.35	0.78	5.14	0.70	355.33	0.78	6.84	1.04
DC1002-28-h	973.51	0.78	3.99	0.26	439.20	0.00	10.10	1.07	1006.94	0.00	4.66	0.32	355.91	0.90	6.15	0.31
DC1002-29-h	973.12	0.78	4.23	0.50	439.39	0.78	10.99	0.94	1006.35	0.78	5.29	0.82	355.52	0.00	6.46	0.22
DC1002-30-h	973.31	0.00	4.47	0.32	439.20	0.00	9.52	1.36	1006.63	0.77	5.37	0.45	355.52	0.00	6.86	0.73
DC1002-31	973.51	0.78	4.70	0.78	439.20	0.00	9.01	0.82	1006.35	0.78	5.44	1.21	355.68	0.63	7.37	1.03
DC1002-32	973.12	1.50	4.14	0.20	439.39	0.78	10.14	3.28	1006.35	0.78	5.86	2.03	354.94	1.97	7.57	1.87

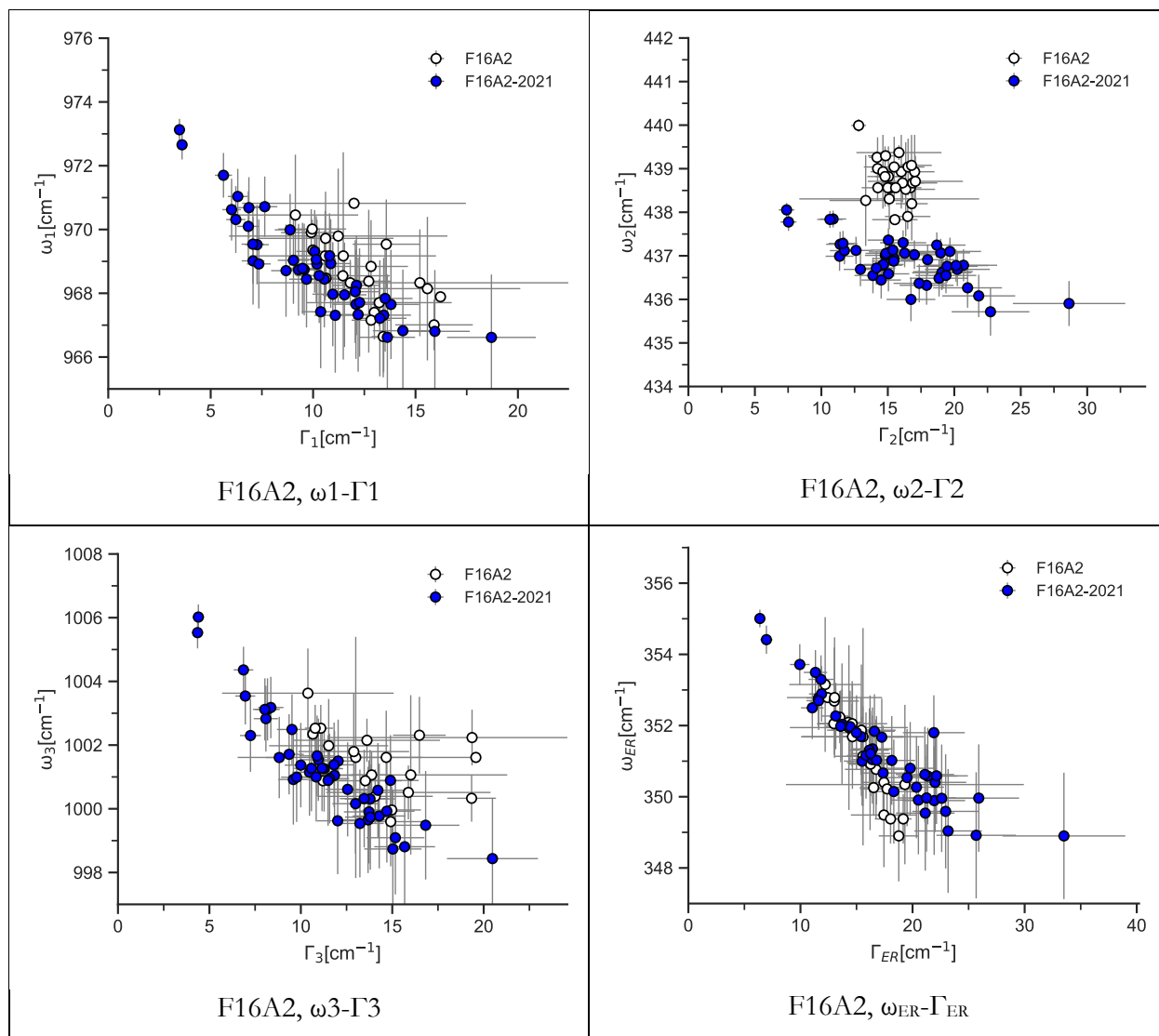
Spot	Th232 (ppm)	Th232 2SD ²	U235 (ppm)	U235 2SD ²	U238 (ppm)	U238 2SD ²	D1 (10 ⁻¹⁶ α/g) ³	D1 2SD ³	D2 (10 ⁻¹⁶ α/g) ³	D2 2SD ³	D3 (10 ⁻¹⁶ α/g) ³	D3 2SD ³	Der (10 ⁻¹⁶ α/g) ³	Der 2SD ³	eU (ppm)	eU 2SD ²	Date1 (Ma) ⁴	Date2 (Ma) ⁴	Date3 (Ma) ⁴	DateER (Ma) ⁴
DC1002-01-l	209.26	46.45	1877.48	948.44	607.77	139.22	35.69	9.72	42.02	5.00	29.62	6.50	22.46	6.11	688.38	146.60	163.21	191.71	135.72	103.18
DC1002-02	131.23	49.27	1122.66	720.62	394.76	141.11	20.57	2.29	43.20	5.18	25.83	5.26	16.55	1.68	446.00	148.63	145.35	301.65	182.07	117.25
DC1002-03-l	77.24	18.42	847.28	483.03	290.28	75.61	21.28	2.91	20.31	4.47	16.66	2.20	14.98	2.99	323.33	79.51	206.46	197.24	162.18	146.04
DC1002-04-l	98.13	21.47	735.79	533.20	265.59	68.14	19.77	1.38	21.45	2.71	15.38	4.29	14.47	2.02	302.42	71.73	205.13	222.28	160.12	150.71
DC1002-05-l	106.42	28.44	1257.81	684.82	410.57	83.41			43.53	11.39			16.62	0.61	456.64	87.84		296.92		114.98
DC1002-06-l	156.84	41.38	1253.62	562.30	454.66	122.65	28.09	4.25	54.75	10.18	38.78	9.87	24.15	4.72	515.04	129.16	171.56	330.31	235.65	147.75
DC1002-07-l	100.29	80.03	1026.01	1004.08	381.36	347.33	18.64	6.85	17.13	8.50	12.51	13.01	12.42	4.81	424.50	365.20	138.49	127.35	93.30	92.63
DC1002-08-l	167.17	67.58	1304.57	808.14	438.60	165.45	20.54	1.07	37.56	9.96	28.98	9.84	20.28	3.74	500.65	174.47	129.51	234.86	181.96	127.85
DC1002-09-core-l	117.60	119.56	874.57	907.29	389.07	490.45	28.18	4.24	39.92	2.74	80.62	169.26	22.50	2.08	436.75	515.77	202.48	284.97	563.16	162.20
DC1002-09-rim-l	204.42	58.42	1720.34	1422.23	647.09	159.45	23.79	4.87	31.70	11.06	21.00	3.59	16.64	2.77	728.51	168.01	103.26	137.26	91.23	72.43
DC1002-10-l	87.23	72.15	1076.12	973.67	399.59	321.98	22.29	1.54	35.56	8.00	33.97	7.71	17.99	1.21	440.50	338.53	159.30	252.32	241.27	128.91
DC1002-11-l	171.49	52.97	1560.79	766.15	564.82	180.32	24.26	6.65	29.20	11.62	21.46	12.79	19.12	6.01	634.22	189.76	120.80	145.12	107.00	95.38
DC1002-12-l	130.37	125.39	1297.11	1684.74	439.12	476.03	21.99	4.77	22.06	7.01	18.97	6.17	16.82	3.55	492.36	500.74	140.84	141.29	121.68	107.99
DC1002-13	145.00	115.18	1363.96	1181.98	486.18	305.02			39.45	14.56	24.80	14.42	16.44	4.59	545.29	321.46		226.61	143.40	95.42
DC1002-14-l	59.39	11.85	509.86	330.02	183.62	42.93	17.74	4.72	19.12	9.20	10.82	4.34	14.14	6.08	207.05	45.17	267.49	287.86	164.43	214.14
DC1002-15-l	133.10	29.16	836.87	490.18	317.21	67.98	20.34	5.83	27.64	10.51	26.97	2.95	13.17	3.28	365.02	71.73	175.27	236.97	231.31	114.02
DC1002-16-l	118.27	65.32	1265.02	954.67	438.14	272.84	22.33	1.43	103.51	240.96	18.70	8.12	17.25	2.54	488.43	286.92	144.11	642.53	120.94	111.64
DC1002-17-core-l	465.51	98.84	2616.01	1116.60	931.73	229.71	20.95	15.33	56.78	11.16	33.63	10.14	22.57	2.78	1090.04	242.36	60.97	163.97	97.62	65.68
DC1002-17-rim-l	161.47	54.08	1566.22	661.94	590.25	142.97	13.17	9.18	46.30	18.96	24.86	7.08	17.02	4.83	658.52	150.67	63.44	220.34	119.24	81.87
DC1002-18-l	304.67	101.85	2050.91	888.61	750.72	279.95	23.54	2.00	28.01	7.39	19.26	6.44	16.71	5.79	861.37	294.97	86.52	102.83	70.90	61.55
DC1002-19	146.70	61.67	1475.32	966.94	543.08	271.13	15.73	7.47	28.39	8.27	18.70	7.33	13.33	2.73	605.44	285.07	82.31	147.76	97.74	69.80
DC1002-20	123.77	63.20	874.06	755.15	309.09	196.14	18.06	8.02	27.44	7.33	18.29	12.83	12.05	3.10	354.25	206.50	160.50	242.29	162.55	107.50
DC1002-21	223.53	106.92	1868.40	1133.50	716.98	394.52	31.77	33.69	40.71	18.03	34.49	27.46	17.03	6.31	806.48	415.04	124.38	158.94	134.92	66.97
DC1002-22-l	101.69	30.59	1080.47	565.17	392.42	122.32	23.28	3.71	41.30	2.03	27.70	7.55	14.95	1.14	436.45	128.65	167.86	294.81	199.24	108.26
DC1002-23-l	105.27	58.84	963.94	790.98	401.63	258.50	24.85	4.14	36.72	12.33	21.43	5.84	17.06	2.41	446.97	271.79	174.88	256.71	151.08	120.52
DC1002-24	174.03	106.47	1489.32	1134.27	573.16	350.72			26.68	4.49	19.83	5.29	14.61	2.01	643.59	369.14		130.80	97.48	71.97
DC1002-25-l	94.89	52.28	695.04	585.79	276.96	193.87			28.07	15.01	40.45	11.31	13.88	1.18	313.58	203.95		279.20	398.66	139.57
DC1002-26	584.79	410.52	3821.88	3309.18	1543.83	1286.79	36.49	11.15	60.02	27.90	37.81	13.81	25.34	14.23	1761.37	1354.71	65.71	107.73	68.08	45.69
DC1002-27-l	131.49	74.48	1098.69	754.50	420.73	242.11	24.43	7.62	34.37	12.70	20.63	6.32	16.55	6.09	473.32	254.85	162.49	227.43	137.47	110.50
DC1002-28-l	70.90	21.17	776.69	418.24	308.91	115.07	19.86	2.46	35.03	7.57	16.30	2.89	12.53	1.80	341.37	120.93	182.88	319.11	150.43	115.98
DC1002-29-l	74.47	20.86	974.75	538.57	389.14	117.24	22.10	4.64	41.33	6.66	21.94	7.43	14.35	1.31	426.47	123.20	163.10	301.80	161.98	106.39
DC1002-30-l	157.40	49.77	1079.46	451.08	453.41	153.07	24.40	2.98	30.94	9.67	22.67	4.04	16.66	4.25	513.86	161.16	149.60	189.13	139.14	102.56
DC1002-31	130.26	70.11	1662.82	1390.81	662.81	421.85	26.50	7.27	27.30	5.82	23.35	10.92	19.68	6.02	727.21	443.26	115.14	118.59	101.56	85.69
DC1002-32	374.63	118.12	1892.39	903.29	802.31	268.68	21.27	1.87	35.33	23.23	27.11	18.31	20.79	10.95	932.33	283.54	72.33	119.70	92.03	70.71
DC1002-01-h	322.27	114.29	2042.73	839.60	704.73	156.54	35.69	9.72	42.02	5.00	29.62	6.50	22.46	6.11	817.32	166.64	137.74	161.84	114.50	87.01
DC1002-02	131.23	49.27	1122.66	720.62	394.76	141.11	20.57	2.29	43.20	5.18	25.83	5.26	16.55	1.68	446.00	148.63	145.35	301.65	182.07	117.25
DC1002-03-h	90.44	36.25	934.89	690.52	335.61	165.89	21.28	2.91	20.31	4.47	16.66	2.20	14.98	2.99	374.10	174.41	178.82	170.82	140.41	126.41
DC1002-04-h	100.67	32.80	1144.52	604.38	391.20	120.19	19.77	1.38	21.45	2.71	15.38	4.29	14.47	2.02	434.92	126.45	143.32	155.37	111.76	105.17
DC1002-05-h	217.89	73.81	1265.92	657.08	466.73	132.33			43.53	11.39			16.62	0.61	542.36	140.07		250.89		96.94
DC1002-06-h	431.98	161.95	2014.62	888.92	724.68	204.15	28.09	4.25	54.75	10.18	38.78	9.87	24.15	4.72	864.59	217.86	102.75	198.80	141.41	88.42
DC1002-07-h	139.70	122.38	1384.17	1367.17	455.34	372.35	18.64	6.85	17.13	8.50	12.51	13.01	12.42	4.81	511.63	392.07	115.11	105.84	77.51	76.95
DC1002-08-h	191.46	72.18	1150.61	541.33	441.29	169.14	20.54	1.07	37.56	9.96	28.98	9.84	20.28	3.74	509.30	178.43	127.33	230.94	178.91	125.69
DC1002-09-core-h	346.24	258.28	2509.02	2375.58	871.95	745.82	28.18	4.24	39.92	2.74	80.62	169.26	22.50	2.08	998.64	785.56	89.34	126.18	252.36	71.44
DC1002-09-rim-h	139.91	113.82	1661.13	1903.87	596.57	621.21	23.79	4.87	31.70	11.06	21.00	3.59	16.64	2.77	659.98	652.85	113.89	151.34	100.63	79.90
DC1002-10-h	220.58	122.73	1714.70	1116.52	600.83	376.21	22.29	1.54	35.56	8.00	33.97	7.71	17.99	1.21	683.81	396.11	103.07	163.67	156.45	83.34
DC1002-11-h	224.19	96.50	1680.65	691.37	592.69	173.47	24.26	6.65	29.20	11.62	21.46	12.79	19.12	6.01	676.13	183.61	113.38	136.22	100.42	89.51
DC1002-12-h	235.31	169.27	1751.04	1367.94	634.92	518.95	21.99	4.77	22.06	7.01	18.97	6.17	16.82	3.55	723.14	546.41	96.22	96.53	83.09	73.72
DC1002-13	145.00	115.18	1363.96	1181.98	486.18	305.02			39.45	14.56	24.80	14.42	16.44	4.59	545.29	321.46		226.61	143.40	95.42
DC1002-14-h	182.62	51.58	1384.72	591.71	509.52	159.91	17.74	4.72	19.12	9.20	10.82	4.34	14.14	6.08	578.83	168.36	96.96	104.45	59.30	77.42
DC1002-15-h	323.28	69.98	1662.04	930.39	574.82	117.95	20.34	5.83	27.64	10.51	26.97	2.95	13.17	3.28	681.14	124.98	94.52	128.07	124.99	61.35
DC1002-16-h	184.79	35.76	1303.85	715.07	491.02	109.19	22.33	1.43	103.51	240.96	18.70	8.12	17.25	2.54	559.92	114.97	125.89	563.97	105.63	97.49
DC1002-17-core-h	408.71	208.12	2378.49	888.16	864.07	269.96	20.95	15.33	56.78	11.16	33.63	10.14	22.57	2.78	1005.36	287.85	66.08	177.59	105.77	71.18
DC1002-17-rim-h	250.89	81.27	1653.22	564.58	632.84	188.94	13.17	9.18	46.30	18.96	24.86	7.08	17.02	4.83	724.69	199.35	57.68	200.53	108.44	74.44
DC1002-18-h	585.67	175.14	2856.24	1013.43	1071.62	337.97														

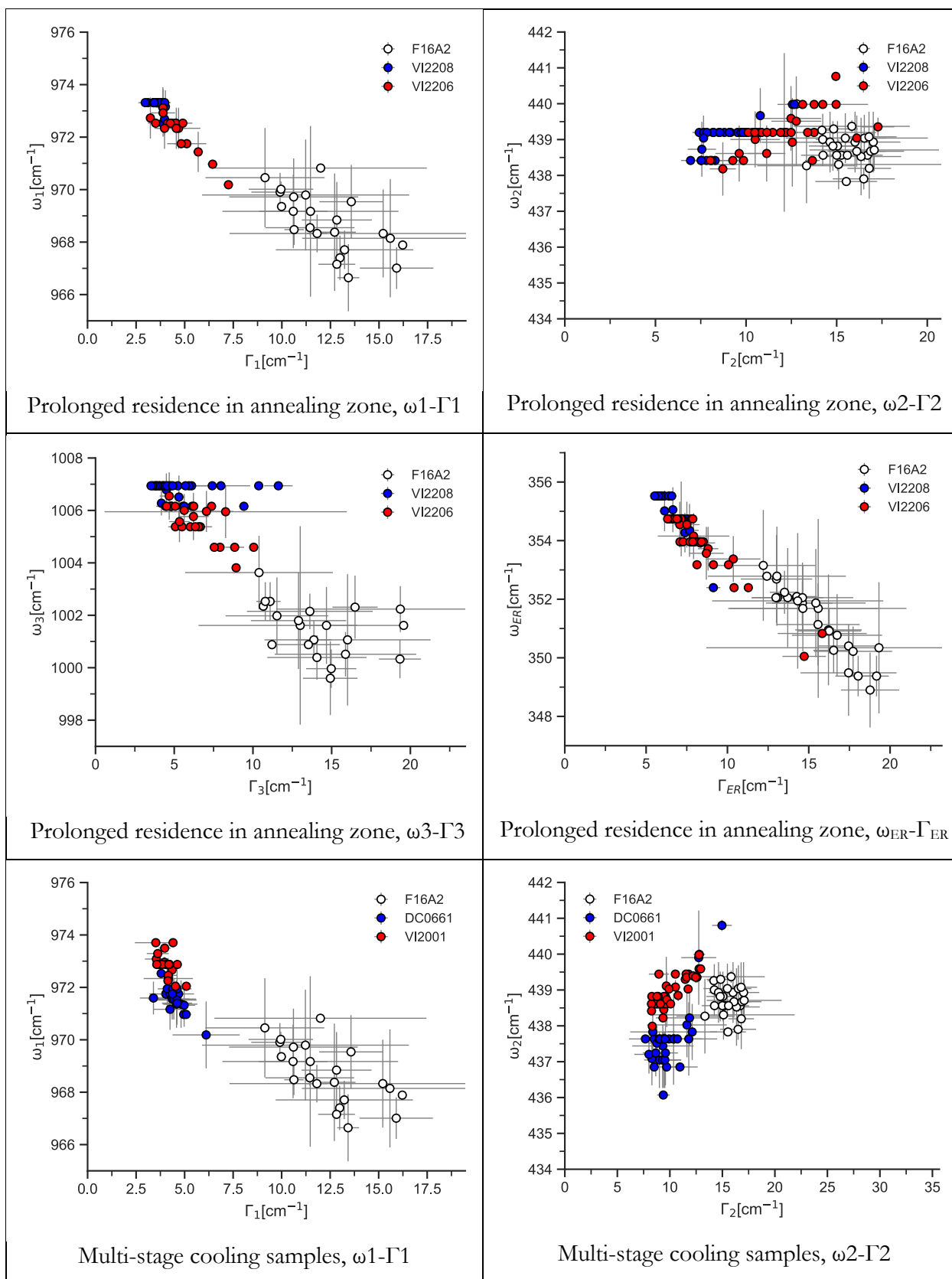
Spot	ω_1^1	$\omega_1 \text{ 2SD}^1$	Γ_1^1	$\Gamma_1 \text{ 2SD}^1$	ω_2^1	$\omega_2 \text{ 2SD}^1$	Γ_2^1	$\Gamma_2 \text{ 2SD}^1$	ω_3^1	$\omega_3 \text{ 2SD}^1$	Γ_3^1	$\Gamma_3 \text{ 2SD}^1$	ω_R^1	$\omega_R \text{ 2SD}^1$	Γ_R^1	$\Gamma_R \text{ 2SD}^1$
CS10109-01-l					438.77	0.30	9.95	0.53	1006.16	0.00	6.88	0.86	354.74	0.00	6.83	0.61
CS10109-02	973.31	0.00	3.81	0.09	439.20	0.00	8.77	0.22	1006.16	0.00	4.95	0.09	354.74	0.00	6.71	0.10
CS10109-03-l	972.73	0.78	4.71	2.14	439.51	1.05	10.90	3.23	1005.96	0.78	6.27	1.99	354.94	0.78	7.11	1.31
CS10109-04-l	973.67	0.69	3.04	0.35	438.42	0.00	7.53	0.75	1006.94	0.00	4.91	0.98	355.52	0.00	6.00	0.20
CS10109-05-l	973.31	0.00	4.10	0.37	439.39	0.78	9.30	1.51	1006.94	0.00	5.53	0.99	354.94	0.78	7.48	1.11
CS10109-06-l	973.12	0.78	3.96	0.56	439.20	0.00	9.42	1.69	1006.94	0.00	5.00	0.87	355.33	0.78	6.62	0.89
	972.53	0.00	4.71	0.16	439.20	0.00	10.19	0.44	1006.16	0.00	6.76	0.50	354.74	0.00	8.50	0.65
CS10109-08-l					440.14	0.26	12.64	1.63	1006.55	1.11	6.98	2.07	354.74	0.00	7.60	0.30
CS10109-09-l	973.31	0.00	4.19	1.64	439.35	0.63	10.29	2.59	1006.35	0.78	5.49	0.52	354.94	0.78	6.81	0.64
CS10109-10-l	972.69	0.63	4.43	0.74	439.98	0.00	11.72	0.71	1006.16	0.00	5.37	0.15	354.74	0.00	7.72	0.13
CS10109-11-l	973.31	0.00	3.76	0.05	439.20	0.00	7.81	0.10	1006.94	0.00	4.17	0.10	355.52	0.00	6.52	0.06
CS10109-12-l	973.70	0.90	3.61	0.38	439.16	0.16	7.83	1.41	1006.94	0.00	4.15	0.66	355.72	0.78	5.95	0.81
CS10109-13					438.42	0.00	8.18	0.29	1006.94	0.00	6.41	0.20	355.52	0.00	6.26	0.12
CS10109-14-l	973.31	0.00	3.63	0.74	439.90	1.65	19.56	33.23	1006.16	0.00	6.77	4.34	354.74	1.81	7.68	2.71
CS10109-15-l	972.53	0.00	5.96	0.11	439.98	0.00	12.34	0.43	1006.16	0.00	6.70	0.13	354.74	0.00	7.69	0.06
CS10109-16-l	973.35	0.16	3.69	0.86	440.68	0.97	13.54	2.49	1006.94	0.00	4.54	0.41	355.52	0.00	6.28	0.27
CS10109-17-core	970.19	0.00	6.74	0.08	441.23	1.88	30.15	63.86	1005.38	0.00	10.57	0.24	351.61	0.00	12.46	2.90
CS10109-17-rim-l	973.31	0.00	3.83	0.06	439.20	0.00	8.75	0.25	1006.94	0.00	4.88	0.07	354.74	0.00	6.64	0.10
CS10109-18-l	972.73	0.78	4.60	1.04	439.20	0.00	9.99	2.17	1005.77	0.90	5.72	1.95	354.35	0.90	7.88	1.45
CS10109-19	973.31	0.00	2.57	0.25	439.24	0.16	10.08	1.83	1006.86	0.18	4.97	0.21	355.25	0.74	6.35	0.27
CS10109-20	973.31	0.00	4.09	0.50	439.20	0.00	8.58	1.13	1006.94	0.00	5.18	0.95	355.13	0.90	7.31	1.19
CS10109-21-l	973.31	0.00	3.83	0.25	439.20	0.00	9.49	0.80	1006.94	0.00	5.64	0.51	354.74	0.00	7.70	0.55
CS10109-22-l	972.92	0.90	4.18	1.07	439.98	0.00	11.08	1.46	1006.16	0.00	6.03	1.94	354.74	0.00	7.41	1.31
	972.73	0.78	4.03	0.28	439.20	0.00	9.79	0.35	1006.16	0.00	5.16	0.31	355.13	0.90	6.95	0.11
CS10109-24-l	972.92	0.90	4.50	1.31	439.20	1.11	10.75	4.37	1006.31	0.63	5.53	0.72	354.94	0.78	7.37	2.04
CS10109-25	973.31	0.00	3.76	0.36	439.39	0.78	8.91	1.59	1006.94	0.00	5.06	1.61	355.33	0.78	6.43	0.77
CS10109-26-l					439.67	0.77	10.95	1.77					355.29	0.74	6.83	0.53
CS10109-27-l	973.20	0.47	4.21	0.94	439.82	0.63	11.42	1.32	1006.43	0.74	6.44	1.29	355.13	0.90	6.99	1.09
CS10109-28-l	973.31	0.00	5.89	2.93	438.81	0.90	8.86	2.13	1006.74	0.78	5.40	1.21	355.52	0.00	7.32	1.26
CS10109-29-l					439.08	0.53	8.85	1.37	1007.33	1.11	8.27	6.18	355.52	0.00	6.40	0.30
CS10109-30	973.31	0.00	3.95	0.24	439.20	0.00	8.70	0.49	1006.20	0.16	4.58	0.44	354.74	0.00	6.85	0.27
CS10109-31-core	973.31	0.00	3.99	0.19	439.20	0.00	8.60	0.14	1006.94	0.00	4.65	0.04	354.74	0.00	7.11	0.14
CS10109-31-rim-l	973.31	0.00	3.59	0.10	439.20	0.00	7.71	0.13	1006.94	0.00	4.12	0.21	355.52	0.00	6.53	0.12
CS10109-32-l	973.31	0.00	4.05	0.99	439.59	0.90	10.92	3.18	1006.86	0.31	6.68	0.96	355.25	0.74	6.85	1.27
CS10109-33-l	971.55	1.50	6.06	2.87	440.22	0.60	12.75	2.29	1005.65	0.86	8.65	3.88	353.41	1.29	10.15	3.35
CS10109-01-h					438.77	0.30	9.95	0.53	1006.16	0.00	6.88	0.86	354.74	0.00	6.83	0.61
CS10109-02	973.31	0.00	3.81	0.09	439.20	0.00	8.77	0.22	1006.16	0.00	4.95	0.09	354.74	0.00	6.71	0.10
CS10109-03-h	972.73	0.78	4.71	2.14	439.51	1.05	10.90	3.23	1005.96	0.78	6.27	1.99	354.94	0.78	7.11	1.31
CS10109-04-h	973.67	0.69	3.04	0.35	438.42	0.00	7.53	0.75	1006.94	0.00	4.91	0.98	355.52	0.00	6.00	0.20
CS10109-05-h	973.31	0.00	4.10	0.37	439.39	0.78	9.30	1.51	1006.94	0.00	5.53	0.99	354.94	0.78	7.48	1.11
CS10109-06-h	973.12	0.78	3.96	0.56	439.20	0.00	9.42	1.69	1006.94	0.00	5.00	0.87	355.33	0.78	6.62	0.89
	972.53	0.00	4.71	0.16	439.20	0.00	10.19	0.44	1006.16	0.00	6.76	0.50	354.74	0.00	8.50	0.65
CS10109-08-h					440.14	0.26	12.64	1.63	1006.55	1.11	6.98	2.07	354.74	0.00	7.60	0.30
CS10109-09-h	973.31	0.00	4.19	1.64	439.35	0.63	10.29	2.59	1006.35	0.78	5.49	0.52	354.94	0.78	6.81	0.64
CS10109-10-h	972.69	0.63	4.43	0.74	439.98	0.00	11.72	0.71	1006.16	0.00	5.37	0.15	354.74	0.00	7.72	0.13
CS10109-11-h	973.31	0.00	3.76	0.05	439.20	0.00	7.81	0.10	1006.94	0.00	4.17	0.10	355.52	0.00	6.52	0.06
CS10109-12-h	973.70	0.90	3.61	0.38	439.16	0.16	7.83	1.41	1006.94	0.00	4.15	0.66	355.72	0.78	5.95	0.81
CS10109-13					438.42	0.00	8.18	0.29	1006.94	0.00	6.41	0.20	355.52	0.00	6.26	0.12
CS10109-14-h	973.31	0.00	3.63	0.74	439.90	1.65	19.56	33.23	1006.16	0.00	6.77	4.34	354.74	1.81	7.68	2.71
CS10109-15-h	972.53	0.00	5.96	0.11	439.98	0.00	12.34	0.43	1006.16	0.00	6.70	0.13	354.74	0.00	7.69	0.06
CS10109-16-h	973.35	0.16	3.69	0.86	440.68	0.97	13.54	2.49	1006.94	0.00	4.54	0.41	355.52	0.00	6.28	0.27
CS10109-17-core	970.19	0.00	6.74	0.08	441.23	1.88	30.15	63.86	1005.38	0.00	10.57	0.24	351.61	0.00	12.46	2.90
CS10109-17-rim-h	973.31	0.00	3.83	0.06	439.20	0.00	8.75	0.25	1006.94	0.00	4.88	0.07	354.74	0.00	6.64	0.10
CS10109-18-h	972.73	0.78	4.60	1.04	439.20	0.00	9.99	2.17	1005.77	0.90	5.72	1.95	354.35	0.90	7.88	1.45
CS10109-19	973.31	0.00	2.57	0.25	439.24	0.16	10.08	1.83	1006.86	0.18	4.97	0.21	355.25	0.74	6.35	0.27
CS10109-20	973.31	0.00	4.09	0.50	439.20	0.00	8.58	1.13	1006.94	0.00	5.18	0.95	355.13	0.90	7.31	1.19
CS10109-21-h	973.31	0.00	3.83	0.25	439.20	0.00	9.49	0.80	1006.94	0.00	5.64	0.51	354.74	0.00	7.70	0.55
CS10109-22-h	972.92	0.90	4.18	1.07	439.98	0.00	11.08	1.46	1006.16	0.00	6.03	1.94	354.74	0.00	7.41	1.31
	972.73	0.78	4.03	0.28	439.20	0.00	9.79	0.35	1006.16	0.00	5.16	0.31	355.13	0.90	6.95	0.11
CS10109-24-h	972.92	0.90	4.50	1.31	439.20	1.11	10.75	4.37	1006.31	0.63	5.53	0.72	354.94	0.78	7.37	2.04
CS10109-25	973.31	0.00	3.76	0.36	439.39	0.78	8.91	1.59	1006.94	0.00	5.06	1.61	355.33	0.78	6.43	0.77
CS10109-26-h					439.67	0.77	10.95	1.77					355.29	0.74	6.83	0.53
CS10109-27-h	973.20	0.47	4.21	0.94	439.82	0.63	11.42	1.32	1006.43	0.74	6.44	1.29	355.13	0.90	6.99	1.09
CS10109-28-h	973.31	0.00	5.89	2.93	438.81	0.90	8.86	2.13	1006.74	0.78	5.40	1.21	355.52	0.00	7.32	1.26
CS10109-29-h					439.08	0.53	8.85	1.37	1007.33	1.11	8.27	6.18	355.52	0.00	6.40	0.30
CS10109-30	973.31	0.00	3.95	0.24	439.20	0.00	8.70	0.49	1006.20	0.16	4.58	0.44	354.74	0.00	6.85	0.27
CS10109-31-core	973.31	0.00	3.99	0.19	439.20	0.00	8.60	0.14	1006.94	0.00	4.65	0.04	354.74	0.00	7.11	0.14
CS10109-31-rim-h	973.31	0.00	3.59	0.10	439.20	0.00	7.71	0.13	1006.94	0.00	4.12	0.21	355.52	0.00	6.53	0.12
CS10109-32-h	973.31	0.00	4.05	0.99	439.59	0.90	10.92	3.18	1006.86	0.31	6.68	0.96	355.25	0.74	6.85	1.27
CS10109-33-h	971.55	1.50	6.06	2.87	440.22	0.60	12.75	2.29	1005.65	0.86	8.65	3.88	353.41	1.29	10.15	3.35

Spot	Th232 (ppm)	Th232 2SD ²	U235 (ppm)	U235 2SD ²	U238 (ppm)	U238 2SD ²	D1 (10 ¹⁶ α/g) ³	D1 2SD ³	D2 (10 ¹⁶ α/g) ³	D2 2SD ³	D3 (10 ¹⁶ α/g) ³	D3 2SD ³	Der (10 ¹⁶ α/g) ³	Der 2SD ³	eU (ppm)	eU 2SD ²	Date1 (Ma) ⁴	Date2 (Ma) ⁴	Date3 (Ma) ⁴	DateER (Ma) ⁴
CS10109-01-l	349.54	99.83	2579.43	1146.89	921.34	283.70			33.99	3.73	36.33	7.74	16.52	3.56	1051.29	298.85		102.26	109.25	49.89
CS10109-02	175.97	54.36	1505.69	778.57	528.29	172.85	18.20	0.82	25.57	1.55	18.92	0.83	15.78	0.61	596.94	181.97	96.47	135.13	100.27	83.73
CS10109-03-l	192.21	63.24	1761.11	1009.16	634.87	254.20	26.59	20.01	40.69	22.89	30.85	17.90	18.15	7.66	712.74	267.34	117.86	179.49	136.52	80.67
CS10109-04-l	94.12	39.18	637.40	524.19	242.54	94.97	10.96	3.24	16.83	5.35	18.57	8.79	11.65	1.14	277.25	100.16	124.84	190.64	210.12	132.58
CS10109-05-l	139.28	69.18	1035.75	641.64	384.96	158.74	20.89	3.43	29.37	10.73	24.13	8.96	20.26	6.51	437.63	167.50	150.43	210.46	173.44	145.95
CS10109-06-l	141.59	49.68	1278.59	740.72	447.76	109.24	19.58	5.22	30.19	11.97	19.40	7.84	15.29	5.19	504.13	115.32	122.65	188.11	121.51	95.94
							26.64	1.45	35.67	3.10	35.24	4.47	26.28	3.81	0.00	0.00				
CS10109-08-l	144.29	36.52	931.55	509.91	367.08	119.72			53.03	11.57	37.24	18.66	21.01	1.74	420.06	126.01		390.37	276.62	157.54
CS10109-09-l	217.53	49.83	1714.98	927.91	594.52	135.14	21.69	15.32	36.36	18.35	23.77	4.67	16.38	3.74	676.45	142.39	101.43	169.10	111.07	76.76
CS10109-10-l	382.44	150.21	2342.78	1231.28	800.82	330.25	24.02	6.92	46.50	5.05	22.71	1.35	21.67	0.76	932.65	348.63	81.59	157.02	77.17	73.66
CS10109-11-l	87.96	39.37	725.59	544.75	265.52	94.50	17.74	0.44	18.76	0.72	11.88	0.89	14.70	0.34	299.91	99.67	185.87	196.42	125.09	154.42
CS10109-12-l	120.80	36.12	978.80	586.81	360.85	115.50	16.28	3.54	18.91	9.99	11.69	5.96	11.36	4.71	407.88	121.58	125.97	146.11	90.70	88.16
CS10109-13	115.54	33.82	765.35	523.36	276.85	89.19			21.45	2.03	32.09	1.78	13.15	0.71	318.43	94.00		211.28	313.54	130.35
CS10109-14-l	238.35	69.54	1517.31	724.38	561.83	165.27	16.52	6.90	102.16	235.71	35.36	39.08	21.46	15.83	647.12	174.33	80.86	484.59	171.88	104.85
CS10109-15-l	179.11	123.26	898.52	503.39	326.78	154.73	38.25	1.05	50.89	3.07	34.72	1.20	21.54	0.33	386.11	165.13	308.33	407.08	280.46	175.42
CS10109-16-l	43.71	22.41	435.80	367.90	161.40	87.67	17.06	8.06	59.40	17.63	15.21	3.71	13.29	1.56	179.96	92.21	295.31	974.75	264.04	231.18
CS10109-17-core	762.52	327.70	4008.55	2006.56	1475.24	658.04	45.61	0.76	177.24	452.94	69.56	2.18	49.40	16.94	1732.01	695.40	83.41	318.25	126.77	90.29
CS10109-17-rim-l	258.03	76.40	2354.85	995.73	830.21	279.68	18.40	0.59	25.49	1.74	18.28	0.60	15.39	0.57	933.65	294.23	62.52	86.45	62.11	52.33
CS10109-18-l	132.09	42.58	1306.82	646.75	455.65	151.34	25.57	9.73	34.29	15.40	25.86	17.55	22.64	8.46	510.13	159.23	157.87	210.79	159.60	139.95
CS10109-19	140.61	38.02	1586.02	731.96	563.40	140.90	6.64	2.35	34.88	13.00	19.10	1.85	13.66	1.56	625.31	148.23	33.77	175.44	96.64	69.24
CS10109-20	131.56	44.35	1209.93	559.86	454.08	201.43	20.79	4.67	24.25	8.02	20.96	8.56	19.27	6.97	508.36	211.77	129.06	150.31	130.12	119.75
CS10109-21-l	103.33	35.67	1015.64	641.32	364.24	154.64	18.39	2.31	30.72	5.69	25.15	4.62	21.60	3.24	407.25	162.60	142.35	236.11	193.94	166.93
CS10109-22-l	252.87	89.53	1763.89	851.83	633.41	249.42	21.68	10.05	41.97	10.32	28.63	17.51	19.91	7.66	725.77	262.77	94.53	181.78	124.55	86.85
							20.23	2.66	32.80	2.46	20.79	2.79	17.20	0.65	0.00	0.00				
CS10109-24-l	208.04	73.95	1729.82	1052.85	636.80	279.59	24.63	12.28	39.66	30.99	24.18	6.52	19.64	11.91	718.57	294.11	108.36	173.58	106.41	86.54
CS10109-25	174.35	59.35	1380.35	612.33	489.70	150.99	17.69	3.35	26.59	11.25	19.88	14.53	14.16	4.50	556.03	159.18	100.65	150.70	112.97	80.66
CS10109-26-l	70.85	24.28	857.80	734.31	319.12	149.99			41.09	12.57			16.48	3.11	352.07	157.59		361.75		147.51
CS10109-27-l	96.95	41.95	979.11	907.50	373.36	160.96	21.95	8.82	44.37	9.38	32.37	11.64	17.44	6.35	415.29	169.30	166.30	331.95	243.80	132.49
CS10109-28-l	103.41	44.55	948.34	750.38	342.86	186.57	37.58	27.36	26.22	15.13	23.00	10.87	19.38	7.36	384.82	196.19	304.08	213.65	187.80	158.54
CS10109-29-l	125.43	57.93	987.86	595.29	360.62	203.85			26.14	9.71	48.79	55.72	14.00	1.76	408.75	214.49		200.73	369.75	108.30
CS10109-30	197.03	46.71	1599.93	761.87	580.10	126.62	19.45	2.21	25.08	3.49	15.58	3.97	16.62	1.59	656.40	133.42	93.80	120.68	75.24	80.22
CS10109-31-core	385.52	175.08	2600.80	1409.94	918.08	358.69	19.84	1.74	24.37	1.01	16.24	0.37	18.11	0.81	1056.51	378.96	59.59	73.13	48.82	54.41
CS10109-31-rim-l	119.32	31.35	1053.18	679.82	400.32	156.12	16.10	0.89	18.12	0.91	11.46	1.88	14.76	0.68	448.97	164.09	113.31	127.40	80.85	103.96
CS10109-32-l	74.30	29.42	775.46	496.38	269.12	91.34	20.44	9.30	40.83	22.53	34.48	8.68	16.62	7.41	300.40	96.17	213.35	419.35	355.92	173.99
CS10109-33-l	141.46	56.11	898.50	919.06	363.46	114.42	39.19	26.81	53.81	16.24	52.23	34.92	35.88	19.57	415.59	120.90	293.79	400.08	388.71	269.53
CS10109-01-h	414.09	136.09	2382.77	1086.09	851.90	313.07			33.99	3.73	36.33	7.74	16.52	3.56	993.88	330.34		108.11	115.51	52.76
CS10109-02	175.97	54.36	1505.69	778.57	528.29	172.85	18.20	0.82	25.57	1.55	18.92	0.83	15.78	0.61	596.94	181.97	96.47	135.13	100.27	83.73
CS10109-03-h	338.40	118.39	2247.45	1340.08	837.28	419.16	26.59	20.01	40.69	22.89	30.85	17.90	18.15	7.66	960.36	441.04	87.68	133.69	101.59	59.97
CS10109-04-h	79.65	49.03	689.89	472.92	250.77	115.03	10.96	3.24	16.83	5.35	18.57	8.79	11.65	1.14	282.43	121.35	122.57	187.20	206.33	130.18
CS10109-05-h	171.71	55.96	1228.71	585.21	453.23	165.53	20.89	3.43	29.37	10.73	24.13	8.96	20.26	6.51	517.10	174.32	127.54	178.56	147.09	123.73
CS10109-06-h	265.82	63.14	1813.89	767.08	671.26	213.60	19.58	5.22	30.19	11.97	19.40	7.84	15.29	5.19	768.62	224.79	80.71	124.00	79.96	63.09
							26.64	1.45	35.67	3.10	35.24	4.47	26.28	3.81	0.00	0.00				
CS10109-08-h	276.25	68.52	1666.59	657.65	634.41	147.85			53.03	11.57	37.24	18.66	21.01	1.74	732.43	156.11		226.77	160.09	90.82
CS10109-09-h	202.37	64.61	1776.58	695.94	657.26	178.15	21.69	15.32	36.36	18.35	23.77	4.67	16.38	3.74	738.70	187.70	92.94	155.02	101.78	70.33
CS10109-10-h	820.74	285.13	3244.44	1412.43	1227.47	423.17	24.02	6.92	46.50	5.05	22.71	1.35	21.67	0.76	1485.82	449.57	51.33	99.01	48.55	46.34
CS10109-11-h	182.11	53.90	964.38	684.97	374.94	121.49	17.74	0.44	18.76	0.72	11.88	0.89	14.70	0.34	437.39	128.21	128.02	135.32	86.03	106.28
CS10109-12-h	106.61	33.57	891.53	399.07	326.16	131.63	16.28	3.54	18.91	9.99	11.69	5.96	11.36	4.71	368.06	138.45	139.46	161.72	100.43	97.63
CS10109-13	115.54	33.82	765.35	523.36	276.85	89.19			21.45	2.03	32.09	1.78	13.15	0.71	318.43	94.00		211.28	313.54	130.35
CS10109-14-h	332.46	66.22	1898.55	704.29	708.93	135.94	16.52	6.90	102.16	235.71	35.36	39.08	21.46	15.83	824.17	143.62	63.57	383.52	135.34	82.47
CS10109-15-h	1745.19	403.60	7863.51	2375.36	3069.73	665.07	38.25	1.05	50.89	3.07	34.72	1.20	21.54	0.33	3642.07	705.01	33.39	44.39	30.32	18.83
CS10109-16-h	211.38	123.94	1051.21	741.24	349.19	157.35	17.06	8.06	59.40	17.63	15.21	3.71	13.29	1.56	417.38	167.88	128.99	438.45	115.17	100.69
CS10109-17-core	1983.83	1145.64	5852.62	3325.39	2168.37	1272.14	45.61	0.76	177.24	452.94	69.56	2.18	49.40	16.94	2752.90	1363.75	52.61	202.05	80.05	56.96
CS10109-17-rim-l	259.14	174.03	2619.23	2292.85	941.28	731.88	18.40	0.59	25.49	1.74	18.28	0.60	15.39	0.57	1050.54	769.61	55.60	76.89	55.23	46.53
CS10109-18-h	390.17	139.05	2218.94	1053.47	810.51	329.27	25.57	9.73	34.29	15.40	25.86	17.55	22.64	8.46	944.67	347.34	85.73	114.68	86.68	75.95

C.2 Appendix C Figures

Figure C.1: Plots of band position (ω) against bandwidth (Γ) for $\nu_1(\text{SiO}_4)$, $\nu_2(\text{SiO}_4)$, $\nu_3(\text{SiO}_4)$, and ER Raman bands. The bars denote 2σ uncertainties.





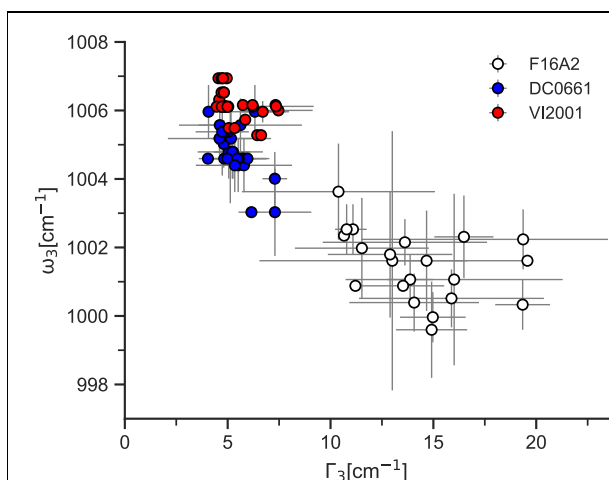
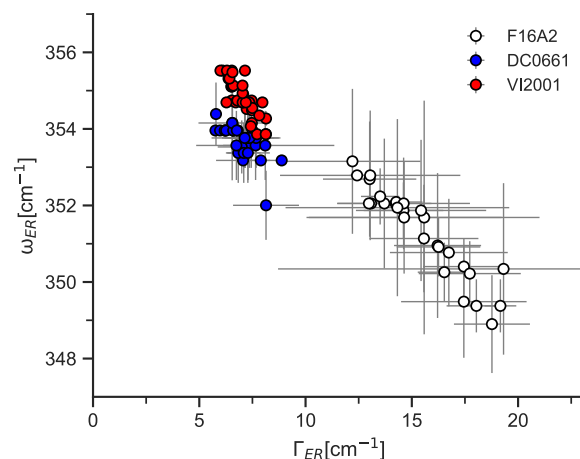
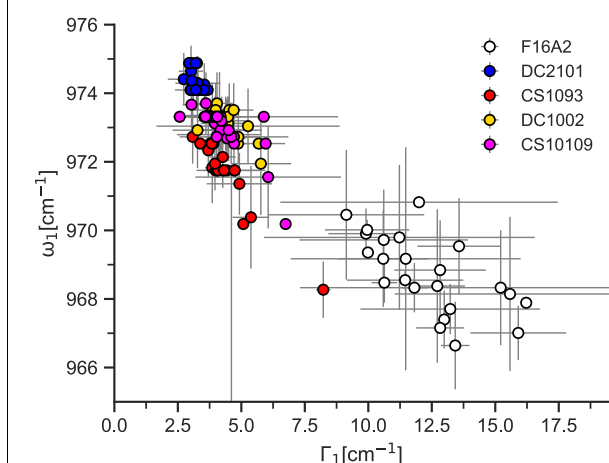
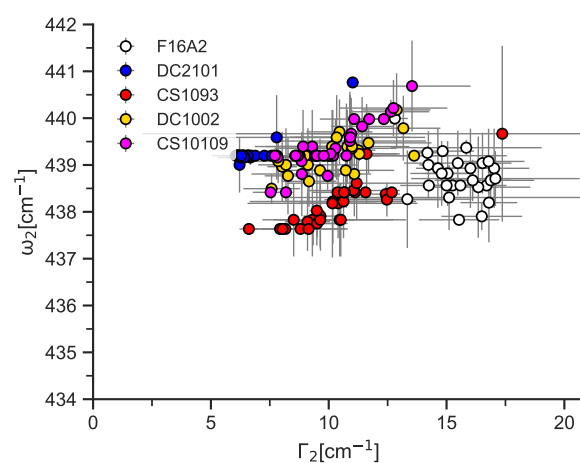
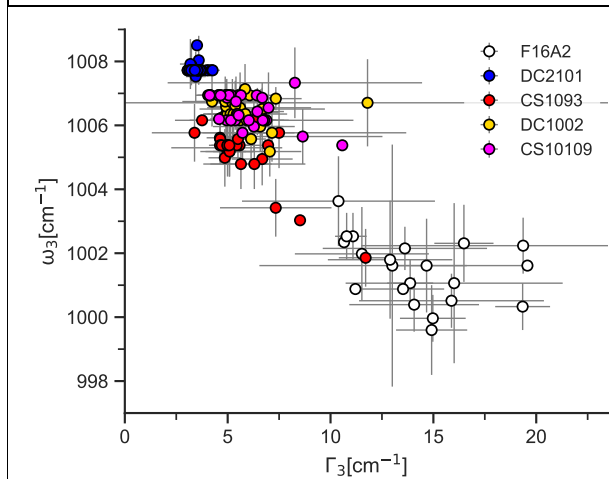
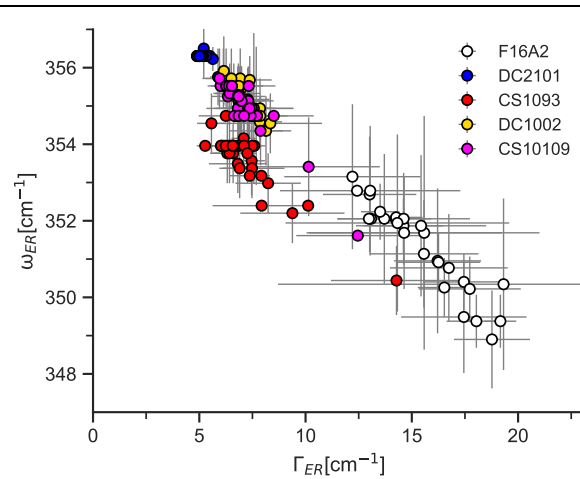
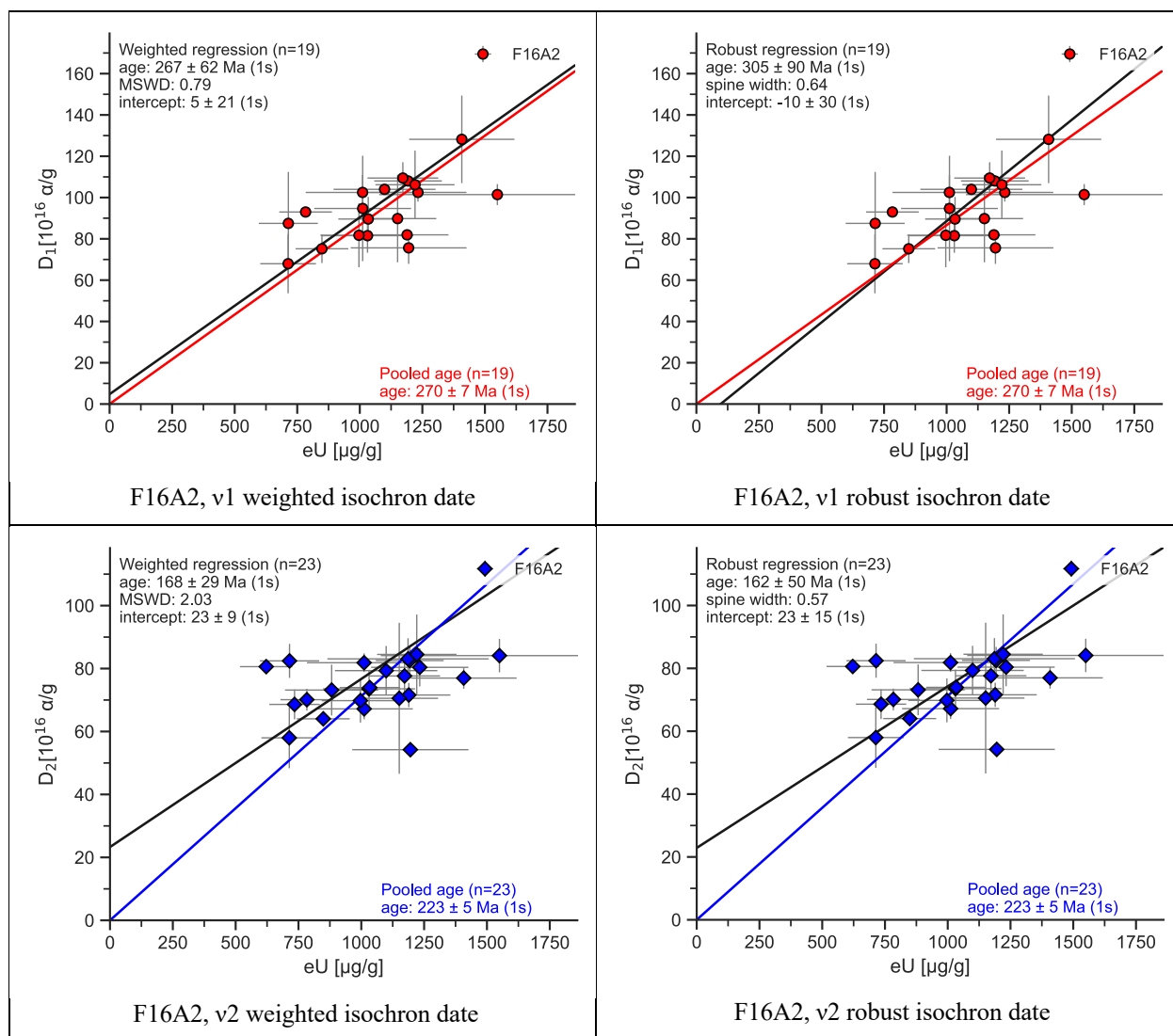
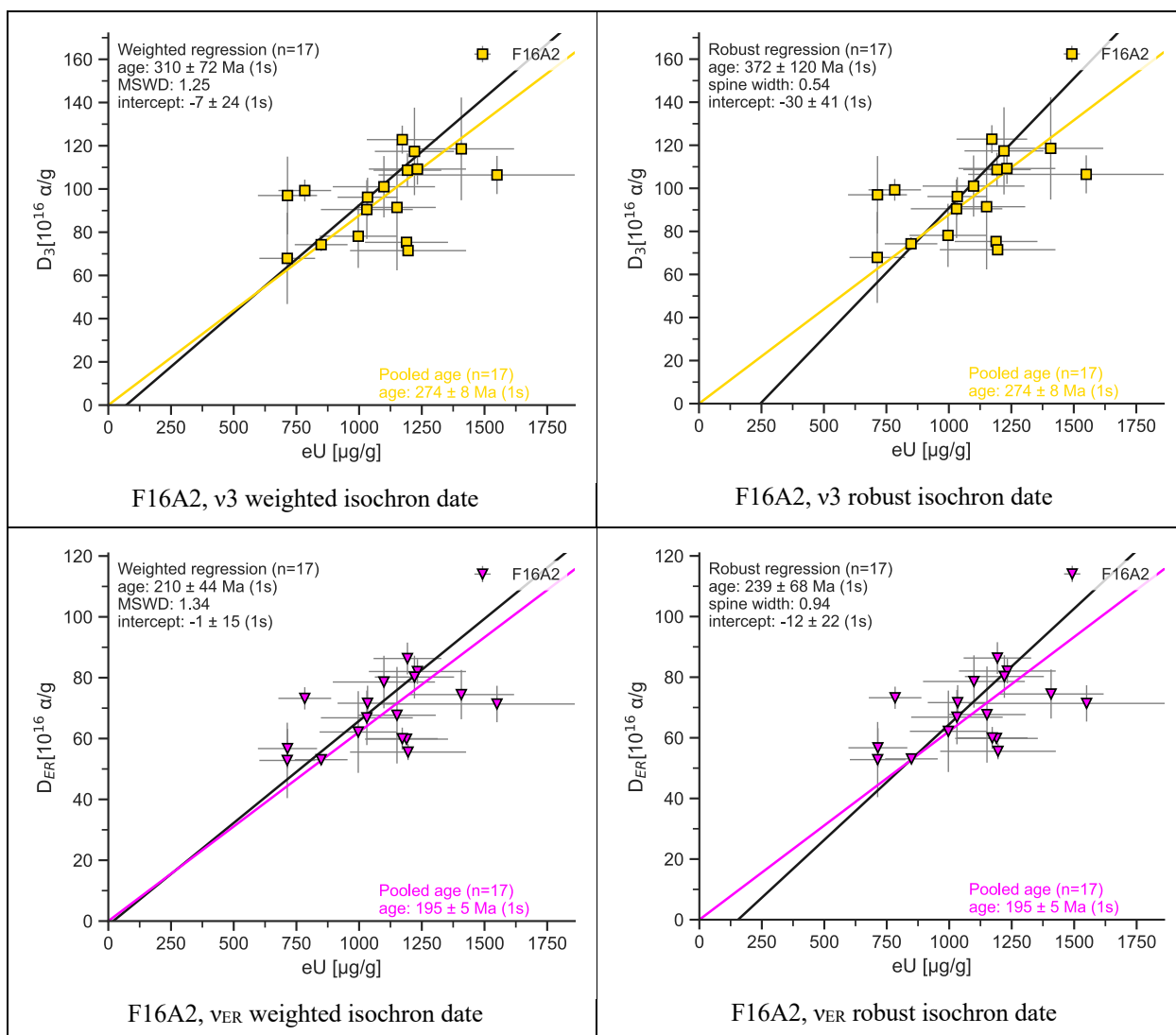
Multi-stage cooling samples, ω_3 - Γ_3 Multi-stage cooling samples, ω_{ER} - Γ_{ER} Eocene plutons & country rocks, ω_1 - Γ_1 Eocene plutons & country rocks, ω_2 - Γ_2 Eocene plutons & country rocks, ω_3 - Γ_3 Eocene plutons & country rocks, ω_{ER} - Γ_{ER}

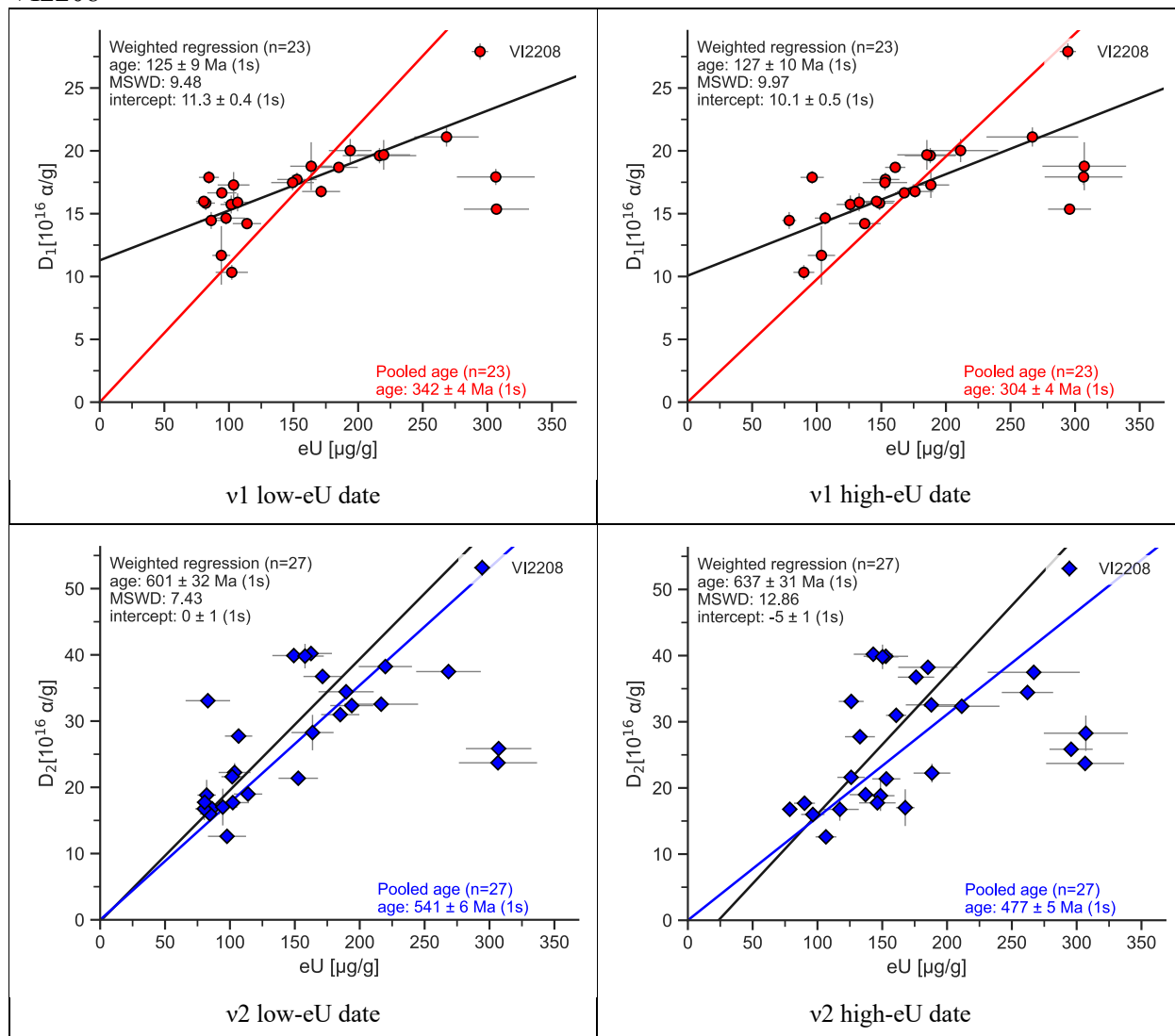
Figure C.2: D vs. eU plots for $\nu_1(\text{SiO}_4)$, $\nu_2(\text{SiO}_4)$, $\nu_3(\text{SiO}_4)$, and ER Raman bands with fitted isochron lines (black) and comparison lines for the pooled ages (colored). Reference sample F16A2 was evaluated using both robust and weighted regression methods. For all Vancouver Island samples, weighted isochron ages were determined at the highest and lowest eU values to constrain the age range.

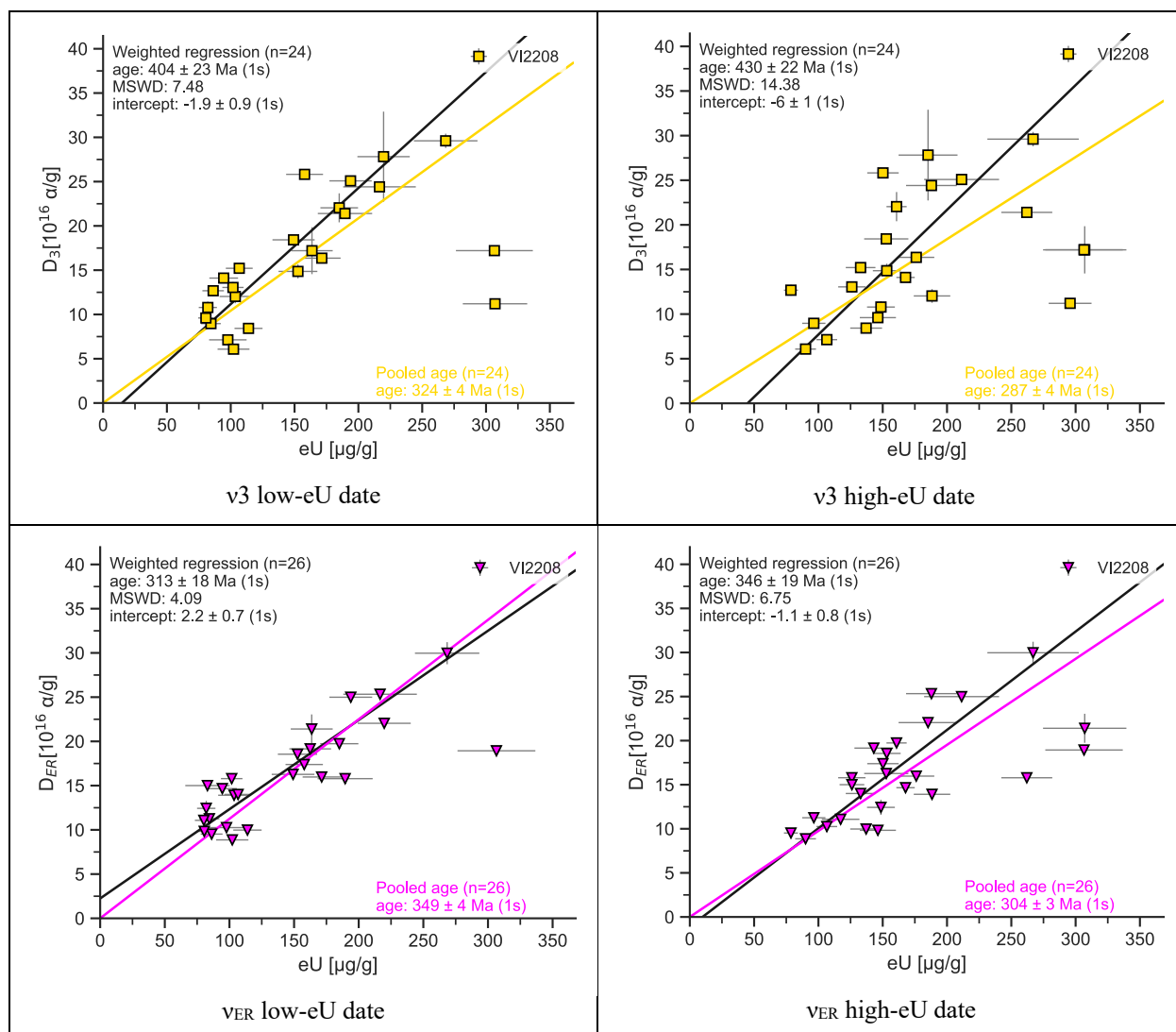
F16A2



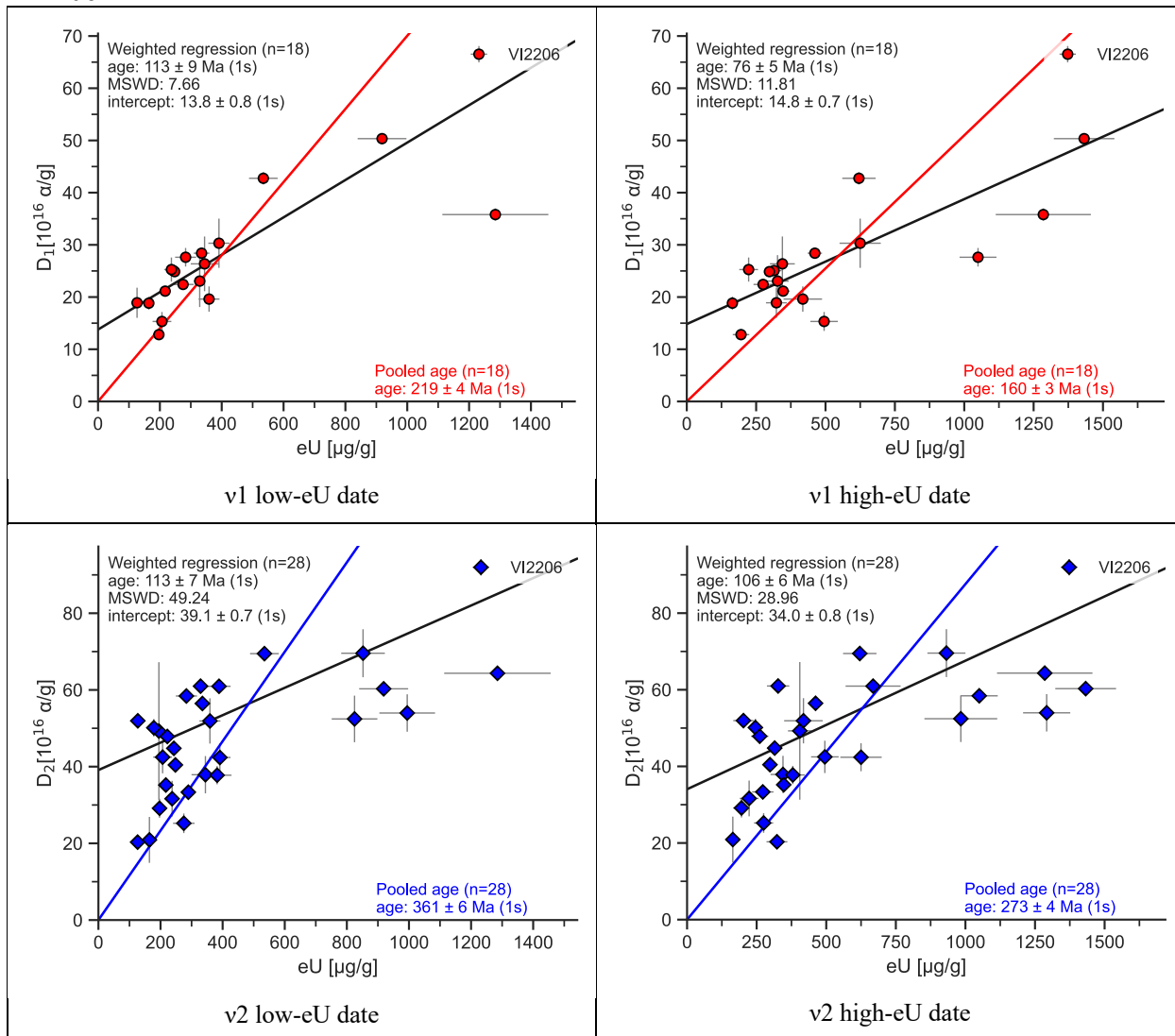


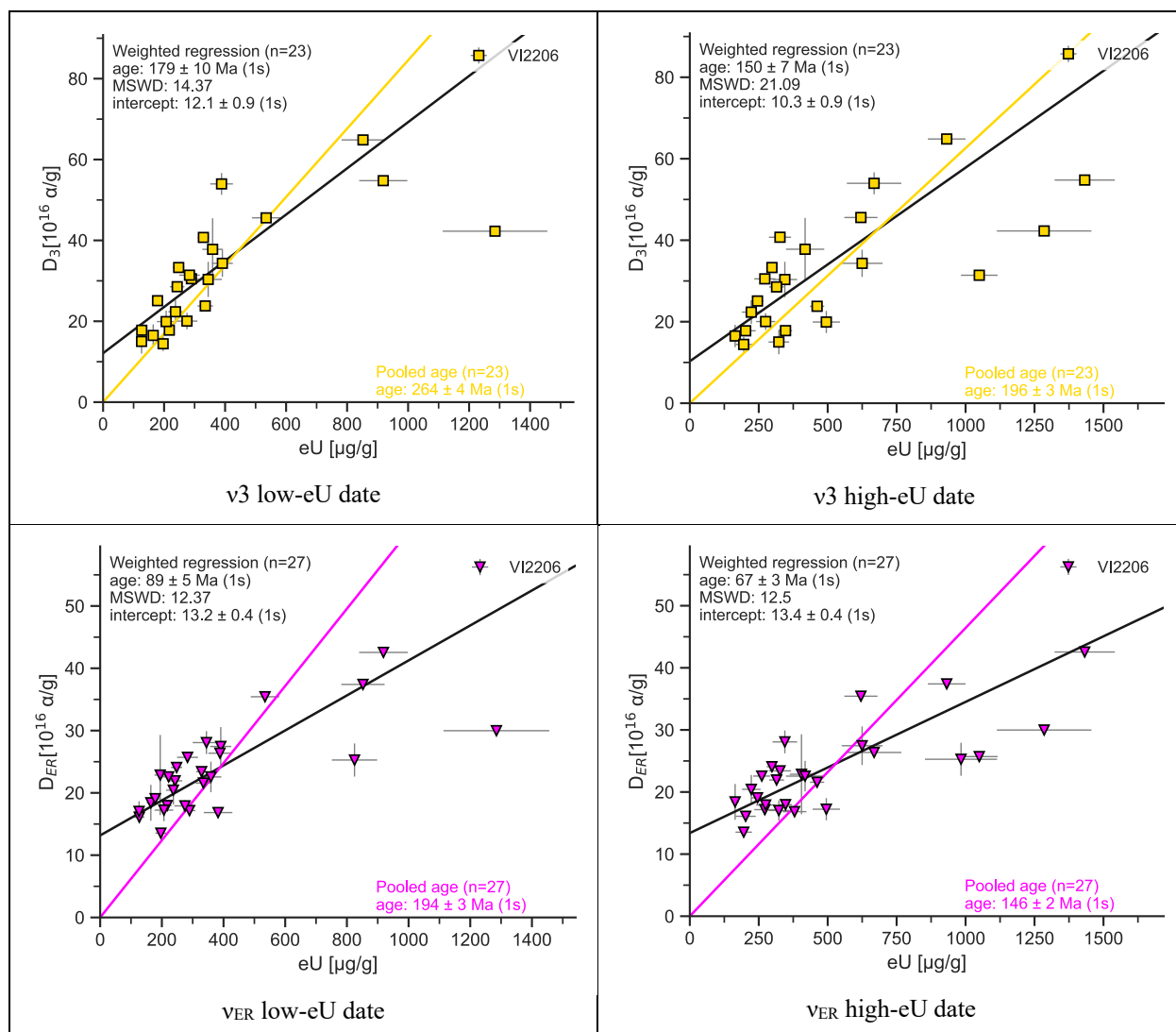
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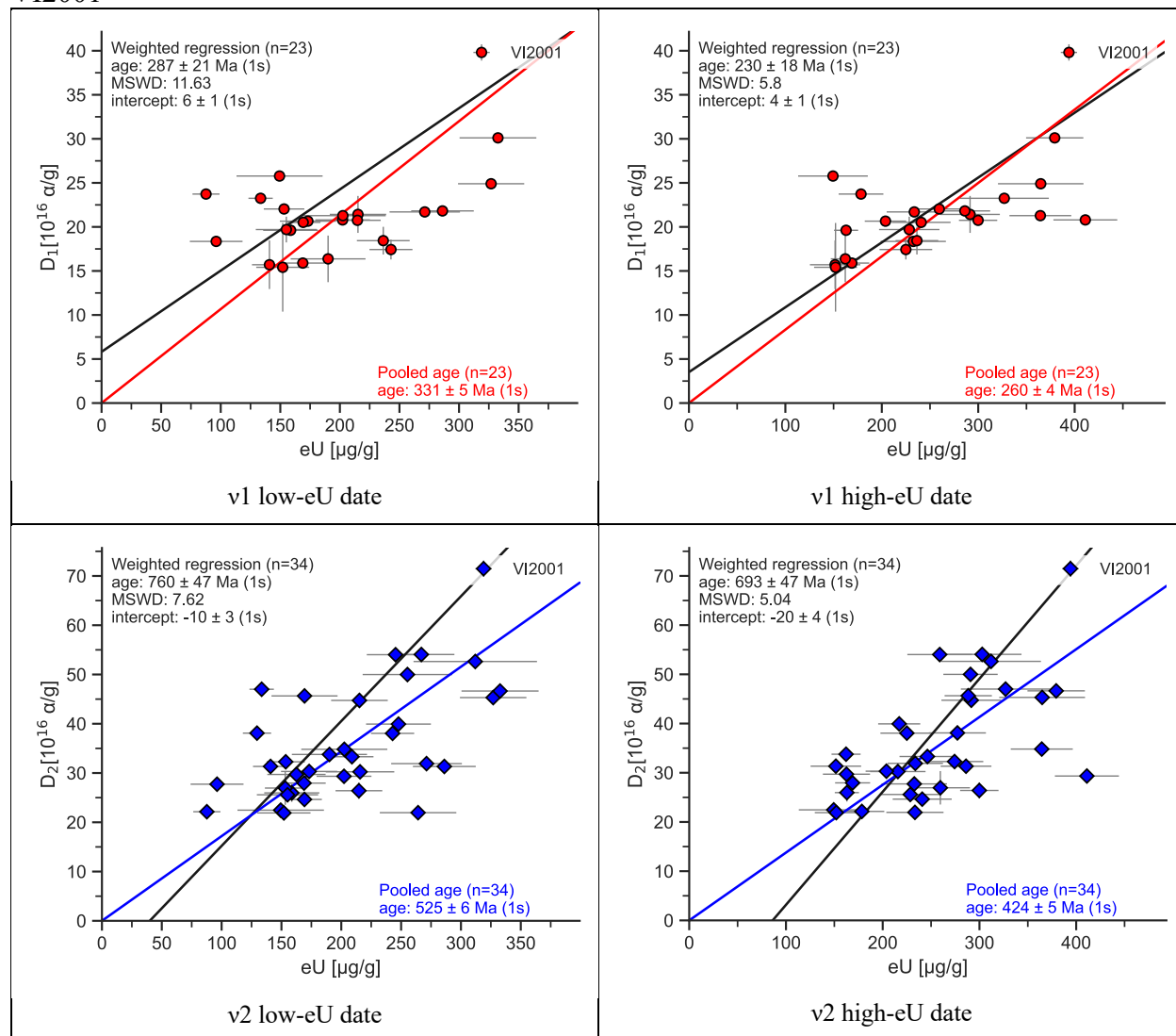


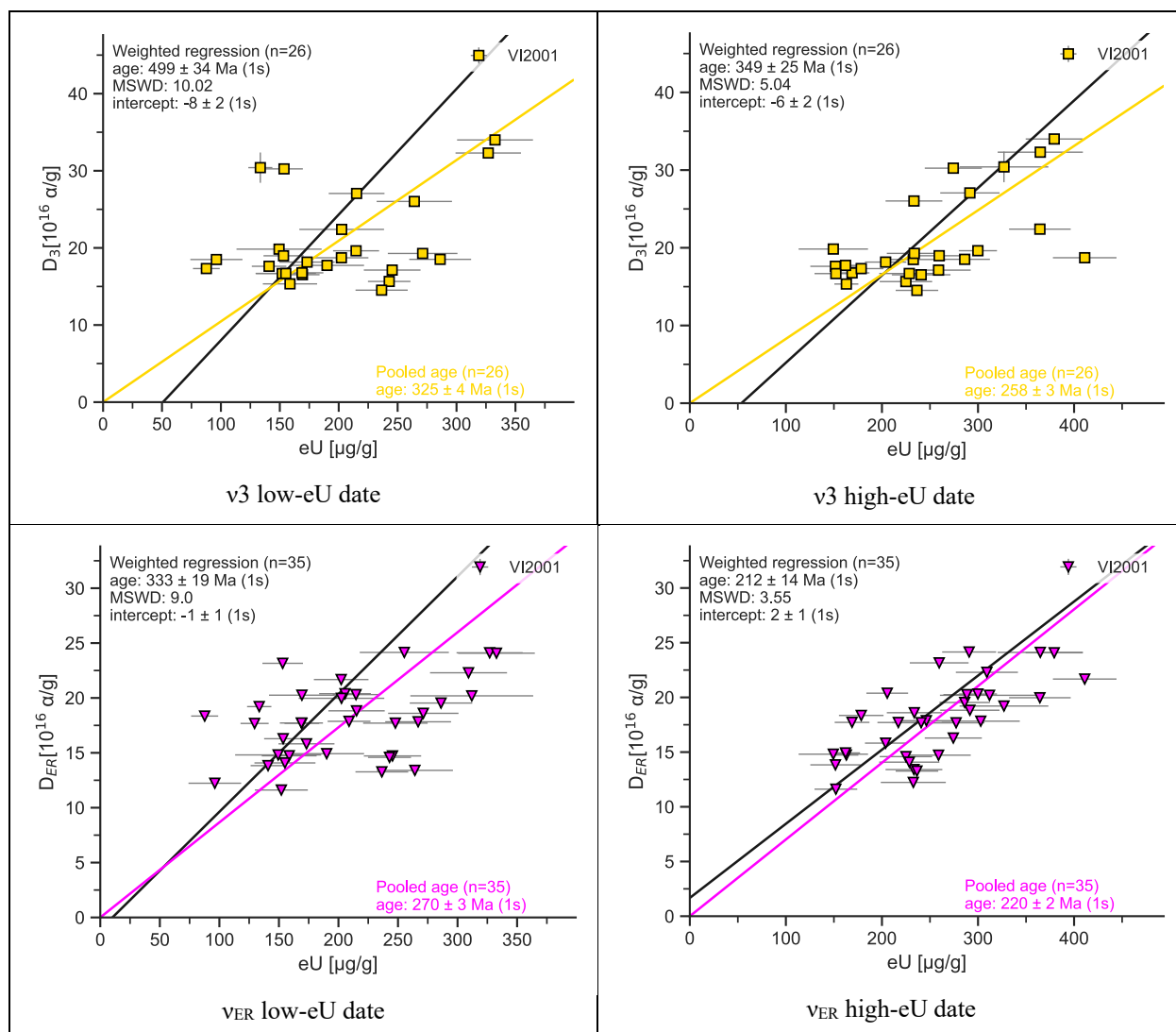
VI2206



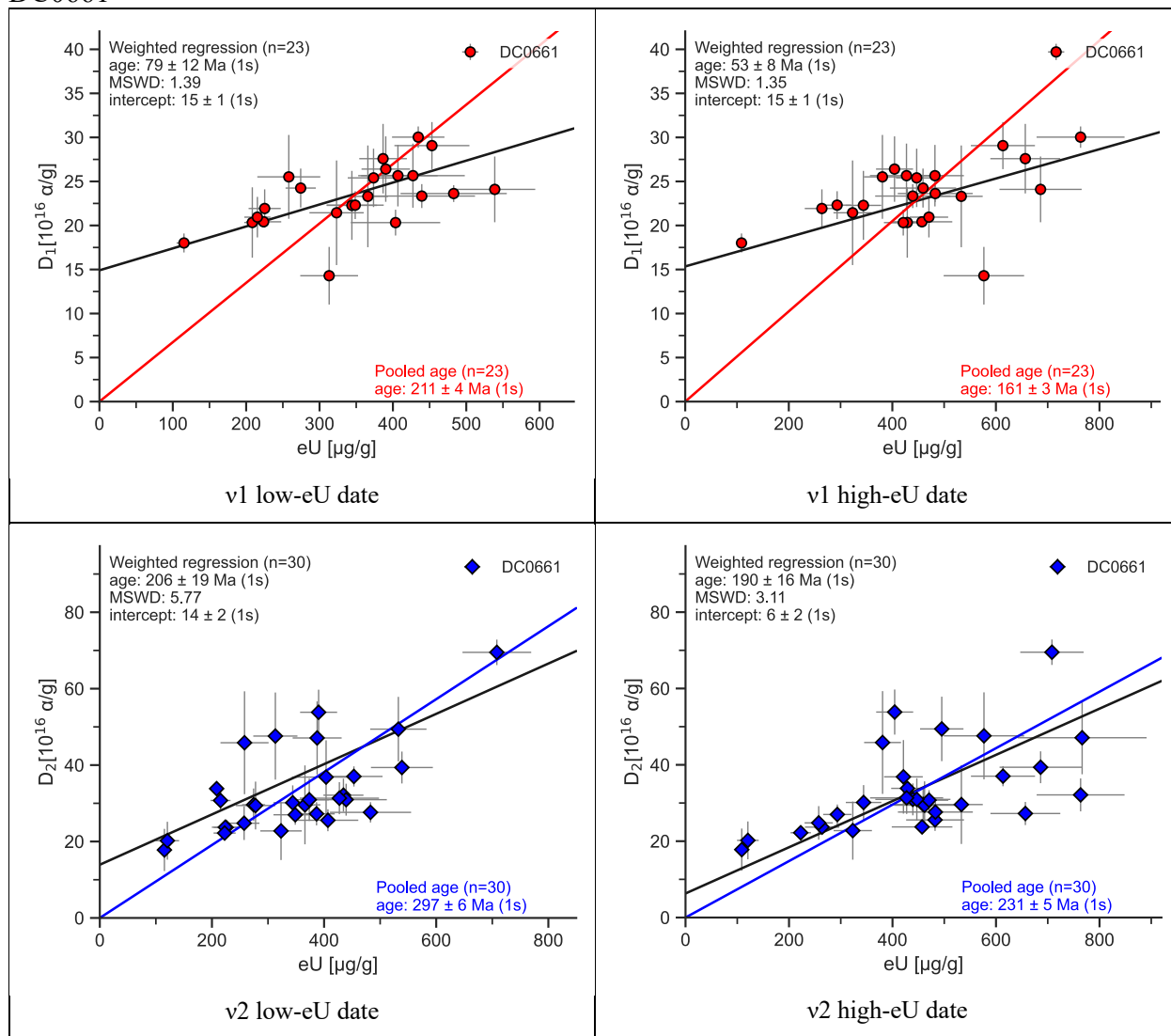


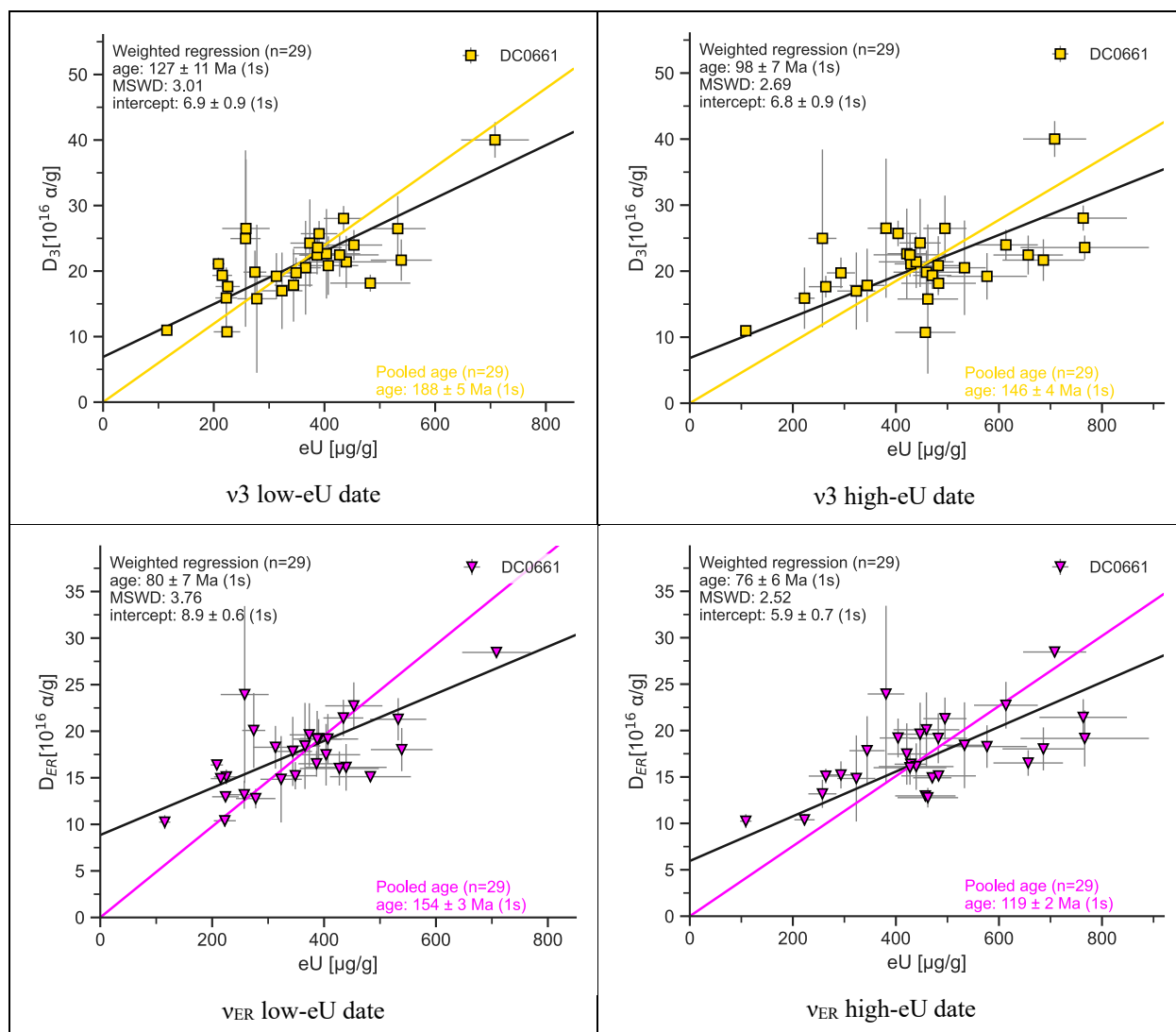
VI2001



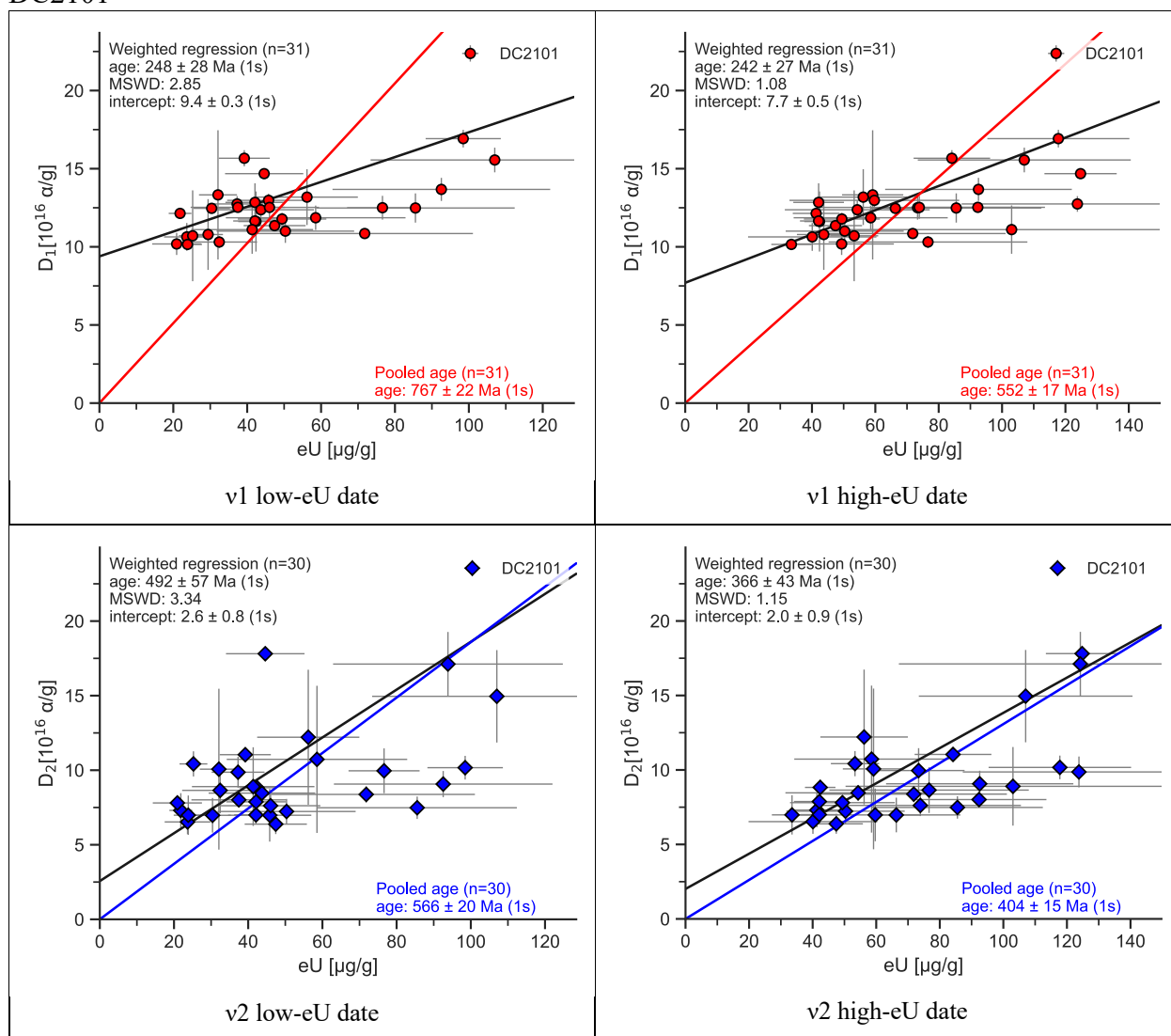


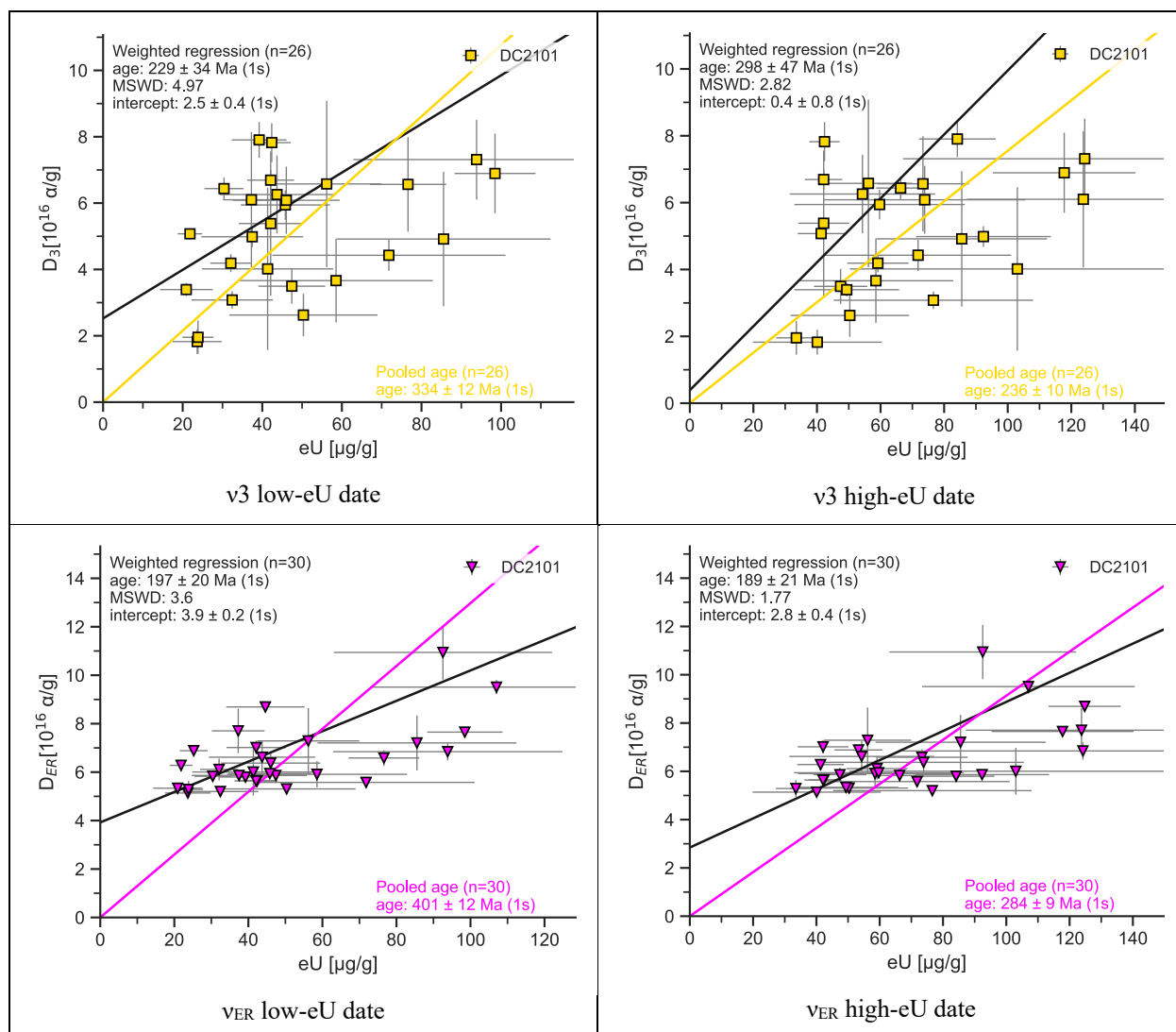
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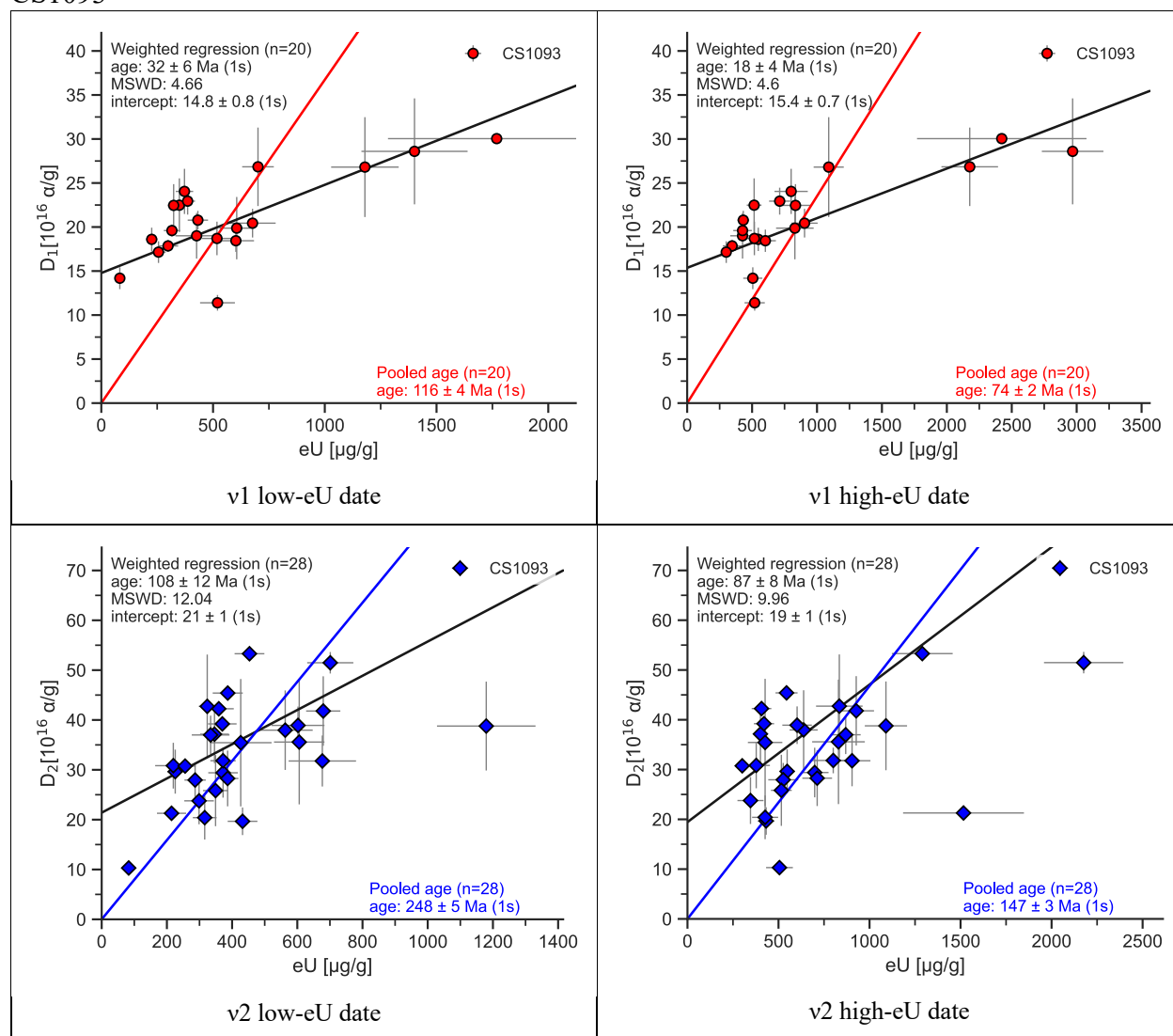


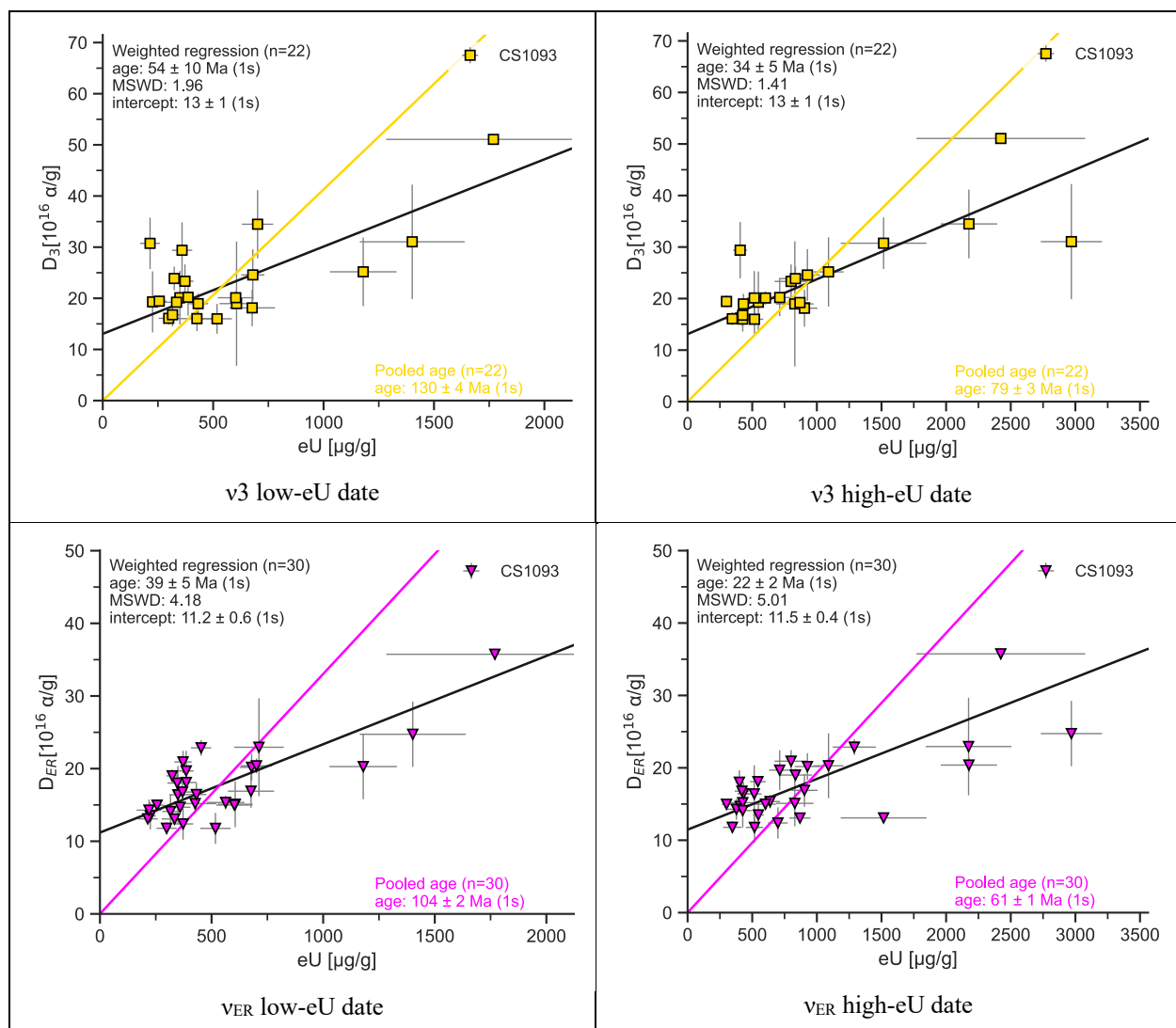
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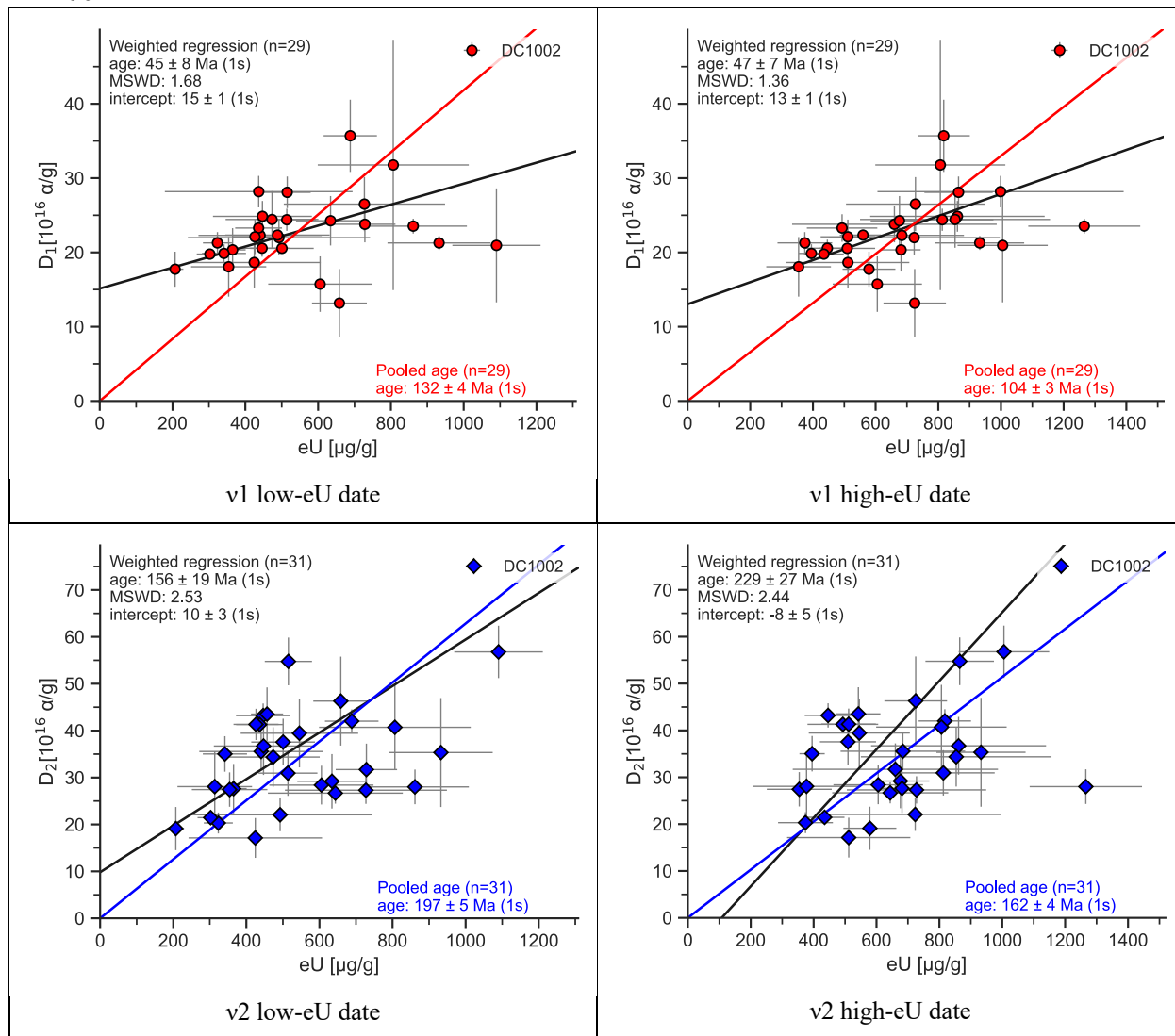


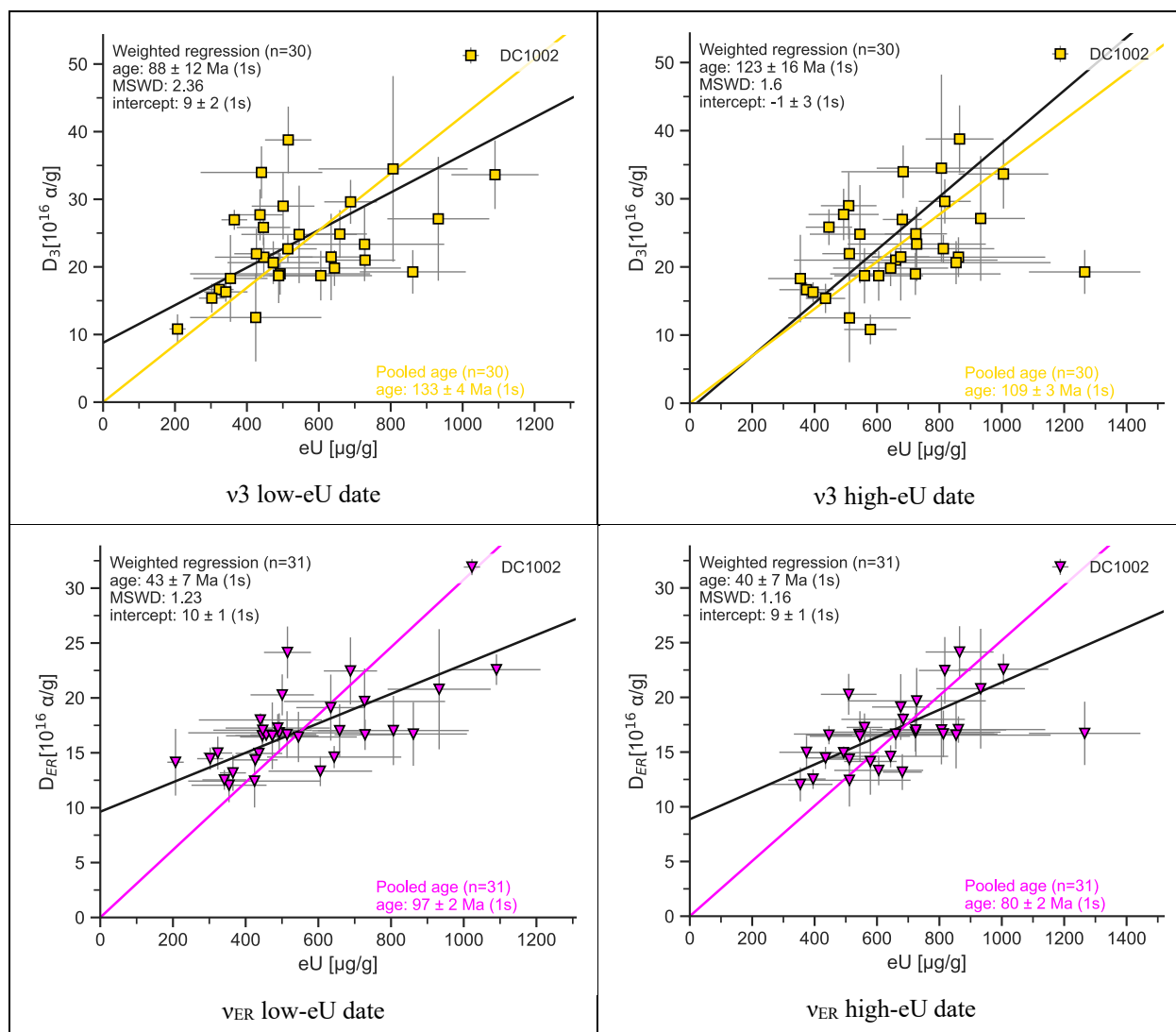
CS1093



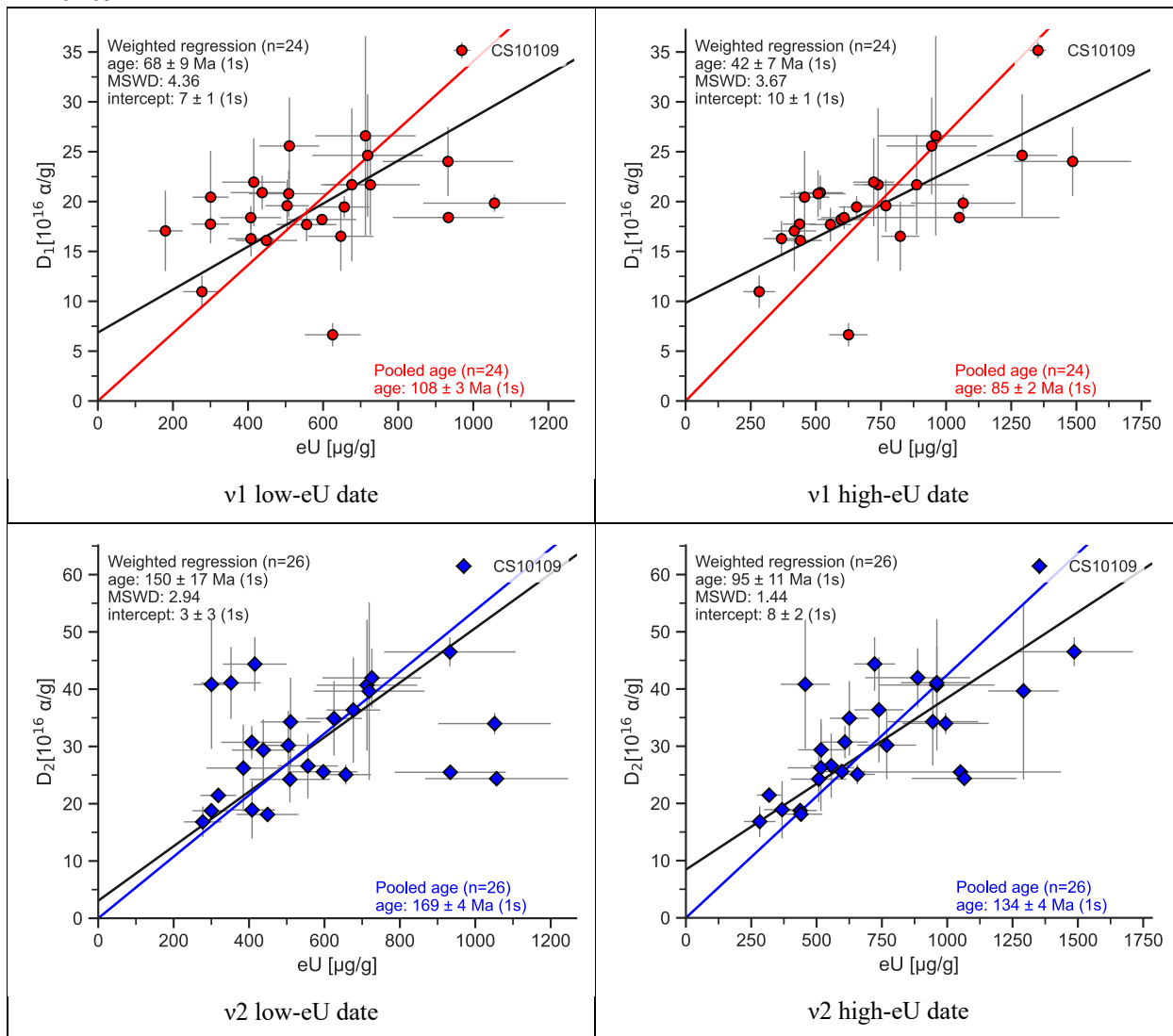


DC1002





CS10109



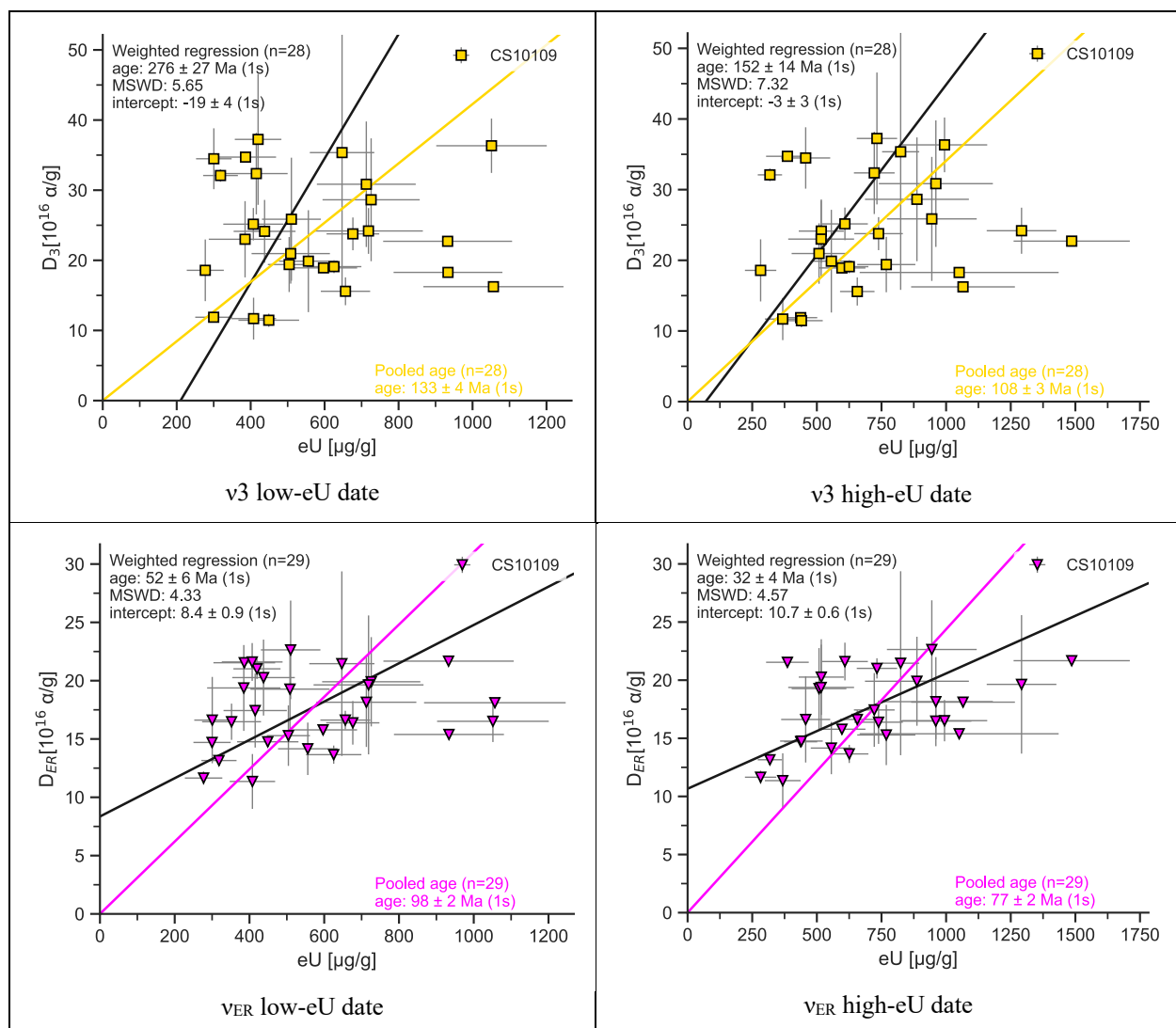
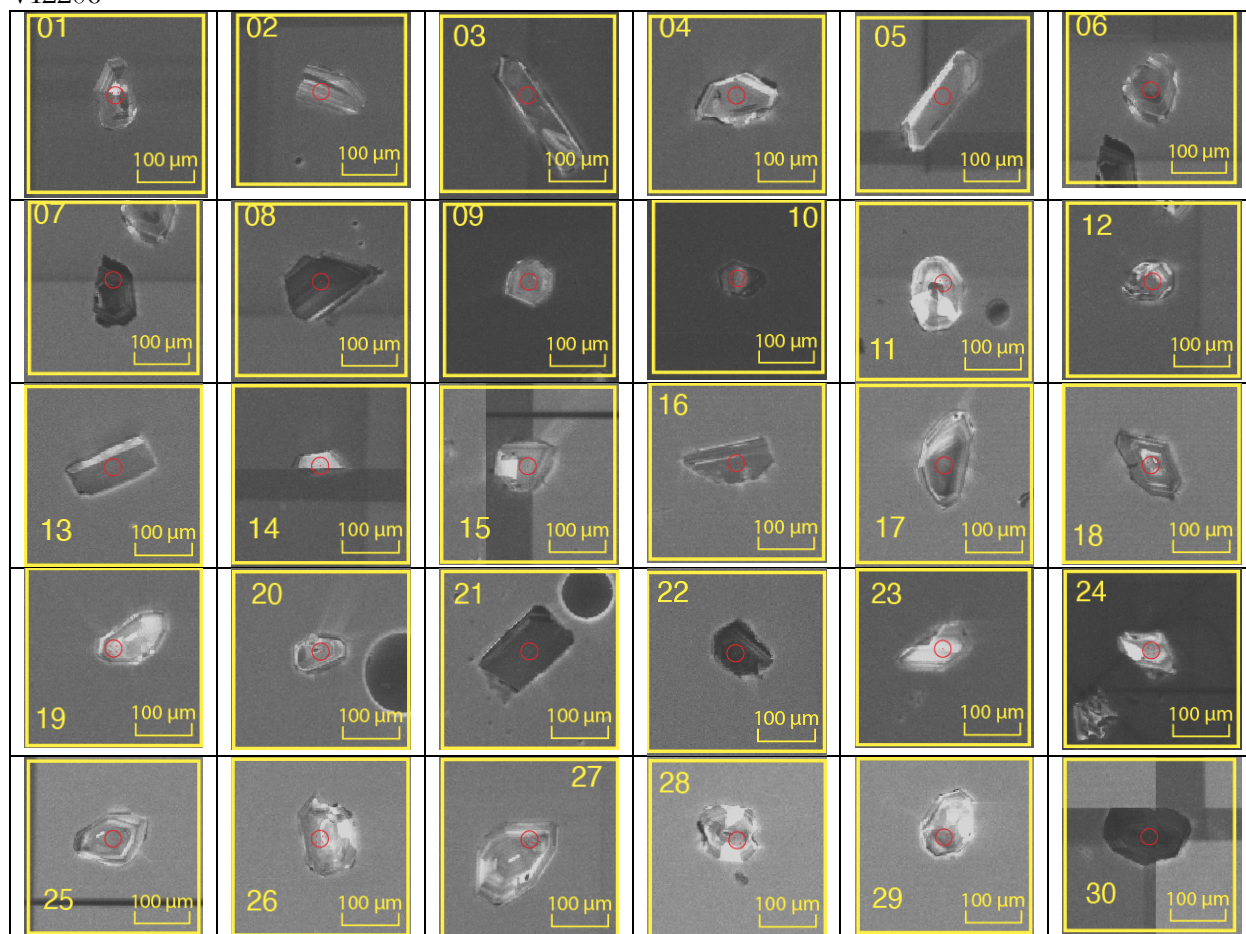


Figure C.3: Cathodoluminescence (CL) images of the zircon grains of samples from Vancouver Island.

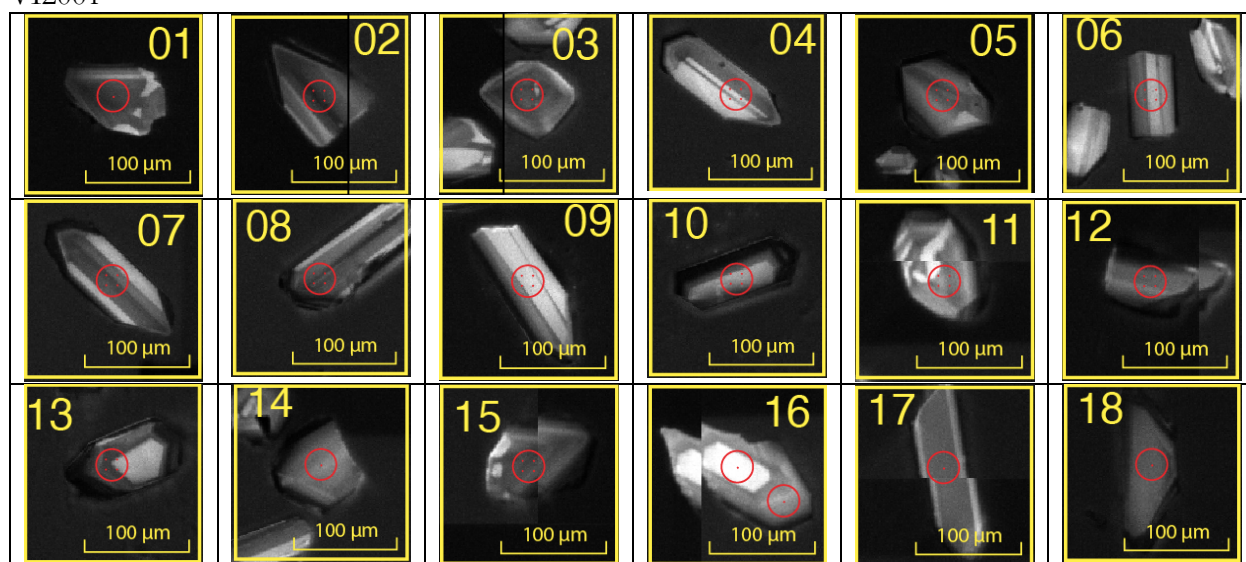
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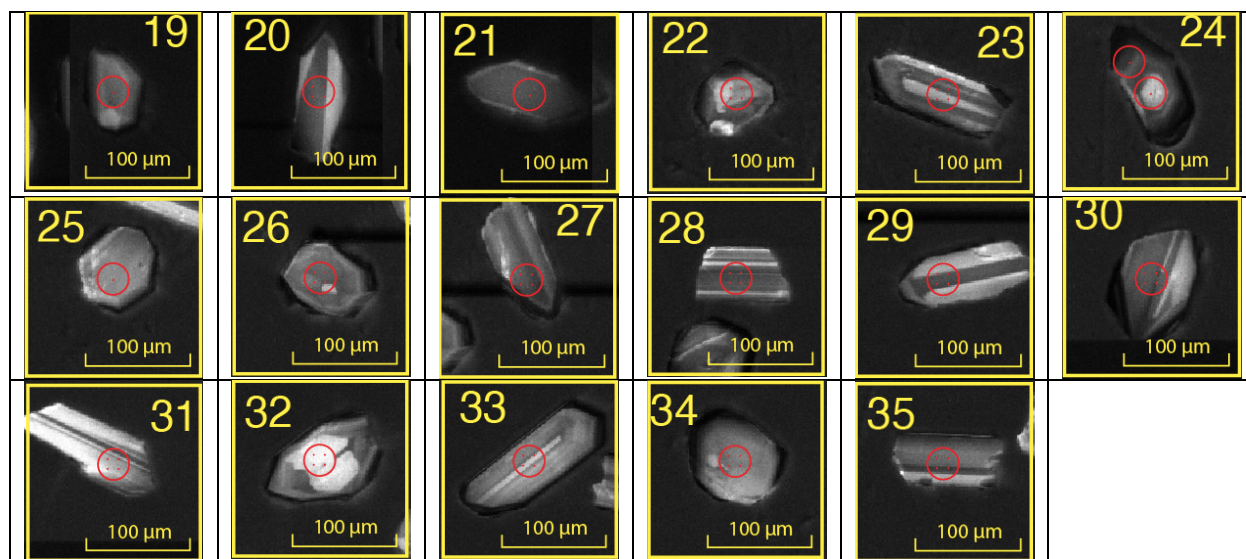


VI2206

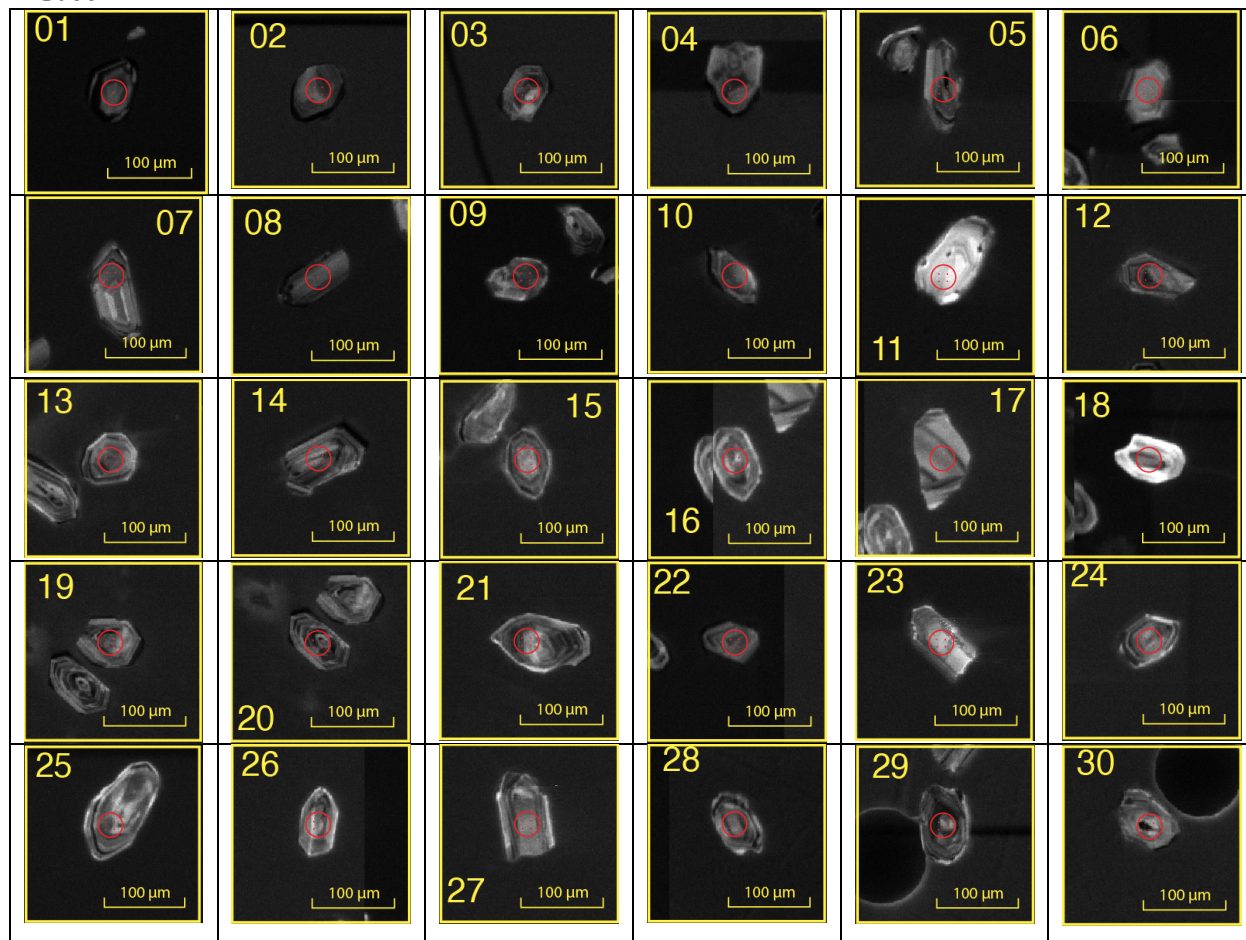


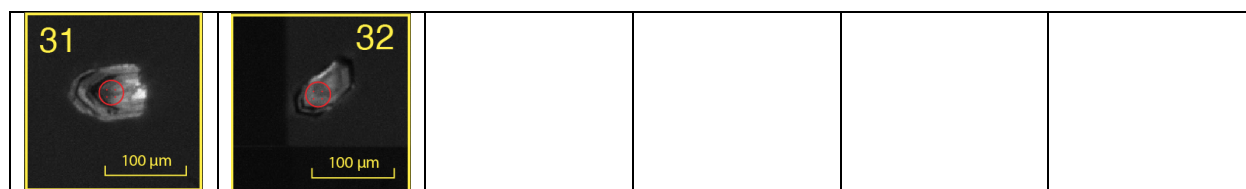
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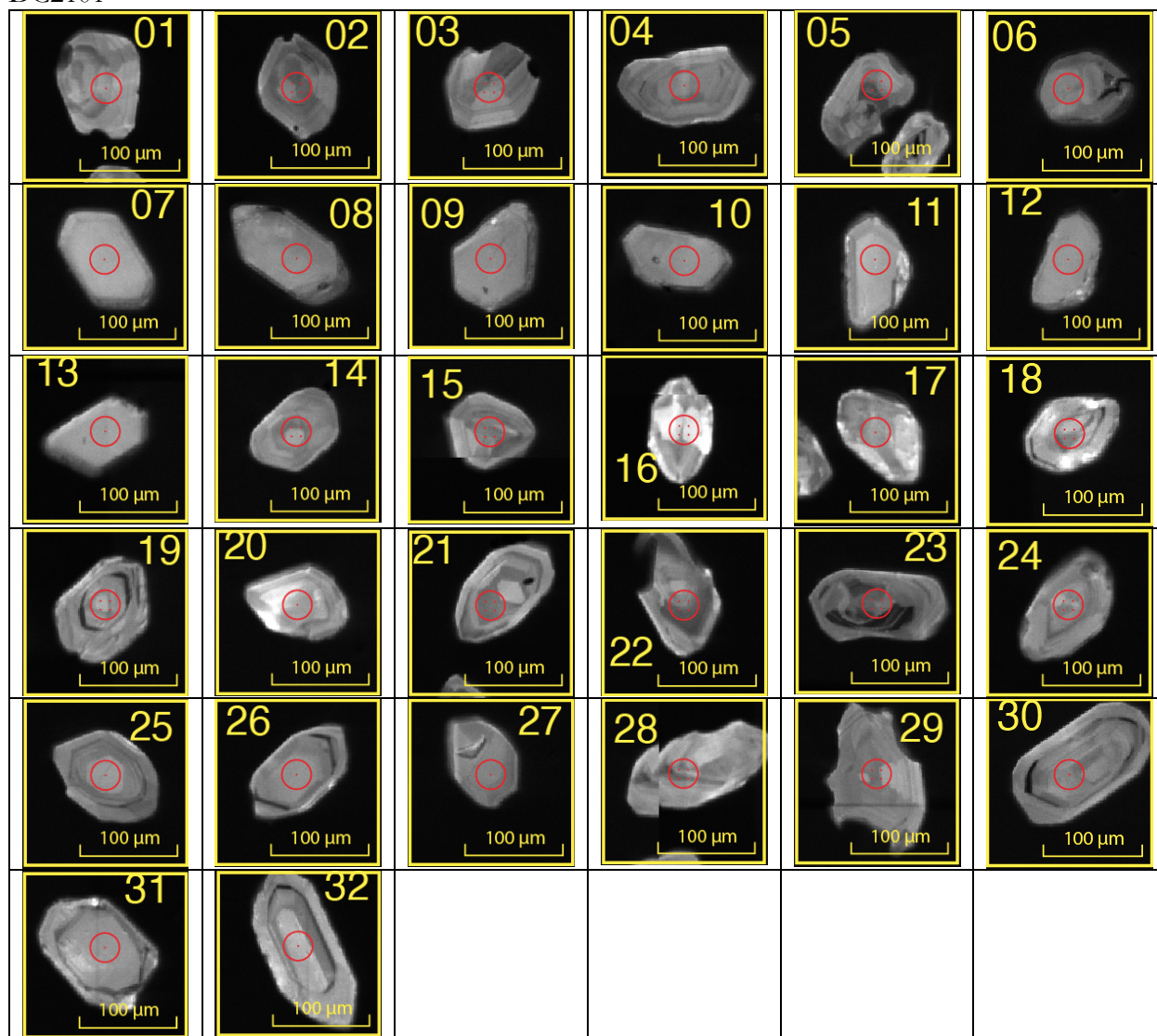


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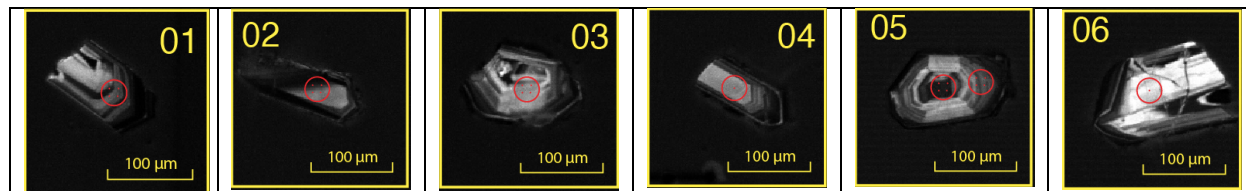




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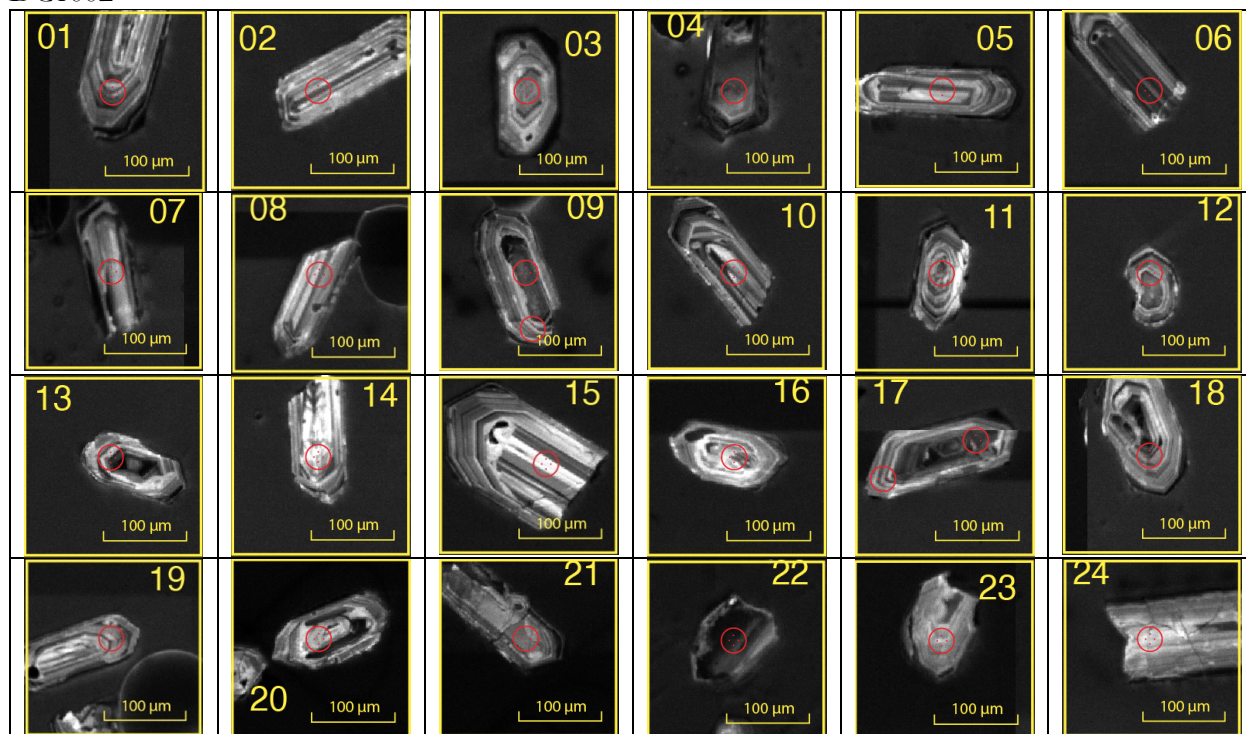


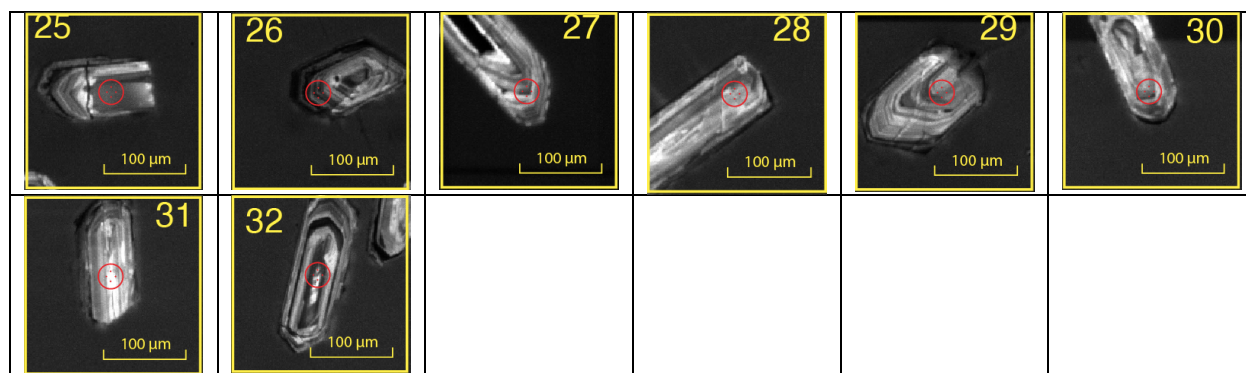
CS1093





DC1002





CS10109

