

Title: Mechanisms for generating elevated zircon $\delta^{18}\text{O}$ in Archean crust: Insights from the Saglek-Hebron Complex, Canada

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Abstract

The Saglek-Hebron Complex (northern Labrador, Canada) is a polymetamorphic terrane preserving felsic crustal rocks as old as 3.87 Ga. Crustal rocks of this age are rare and offer opportunities to interrogate how Earth's earliest continent forming processes may have differed from the modern plate tectonic regime. Oxygen isotope ($\delta^{18}\text{O}$) ratios in primary crystalline zircon are strongly affected by the incorporation of supracrustal materials during magmatism and can provide useful information about the character of early crustal reworking events. While zircon $\delta^{18}\text{O}$ signatures $> +6.4\text{‰}$ indicate the incorporation of supracrustal material into the source of crustal anatexis, questions remain regarding the volumetric scale, sources, and processes by which supracrustal and magmatic mixing occurred during the Archean. Here, we present 271 zircon *in-situ* oxygen isotope analyses for a suite of seven Saglek-Hebron granitoids emplaced between 3.87 and 2.79 Ga in age, significantly expanding the temporal and lithologic diversity of the magmatic SHC zircon $\delta^{18}\text{O}$ record. Collected from carefully characterized grain domains, primary zircon $\delta^{18}\text{O}$ values range from 5.0 to 8.4 ‰ and include some of the highest igneous Archean zircon oxygen isotope ratios recorded to date. Leveraging an integrated zircon workflow for identifying preserved zircon geochemistry, and correlating our new data with previous information from zircon Hf and whole-rock $^{142}\text{Nd}/^{144}\text{Nd}$ isotopes, we identify three periods of contribution from high- $\delta^{18}\text{O}$ supracrustal material to crustal melts during reworking events in the SHC at 3.63, 3.33, and 2.79 Ga. Our work points towards repeated episodes of interaction between a maturing surface environment and magmatism from 3.6 Ga onwards at this locality.

Keywords: Zircon; Oxygen Isotopes; Saglek-Hebron; Early Earth; Archean; Geochemistry

Highlights:

- Zircon $\delta^{18}\text{O}$ tracks interaction between supracrustal material and magmas at Saglek.
- Robust geochemical screening allows interpretation of primary zircon composition.
- Elevated zircon $\delta^{18}\text{O}$ in Archean igneous zircon may result from localized anatexis.

1.0 Introduction

Crustal formation, weathering, and reworking exert first-order controls on the present-day geochemical cycles that make Earth habitable. Characterizing the tectonic regimes operative in the first billion years of planetary history is crucial for understanding the timescales on which solid-Earth processes like magmatism became coupled to climate and Earth-surface-geochemical cycles via the evolution of modern plate tectonics (e.g., Shirey and Richardson, 2011; Dhuime et al., 2012; Rosas and Korenaga, 2018; Hawkesworth et al., 2020). Zircon is a geochemically retentive accessory mineral common in evolved igneous rocks. It has, therefore, served as a versatile and robust archive of the temporal and chemical evolution of continental crust. This is especially important in the Eoarchean and Hadean when unaltered rocks or minerals are relatively rare. When integrated with information about magmatic source and timing from radiogenic isotope systems such as U-Pb and Lu-Hf, stable oxygen isotope ratios ($\delta^{18}\text{O}$) from unaltered zircon domains can record the incorporation of surface-derived sediments or low-temperature altered material into magmas, yielding information about both the surface and magmatic conditions of the early Earth (e.g., Wilde et al., 2001; Valley et al., 2005; Kemp et al., 2007; Iaccheri et al., 2018; Bucholz and Spencer, 2019; Cavosie et al., 2019; Harrison, 2020). However, despite the widespread application of radiogenic and stable isotopes in zircon towards discerning Archean tectonomagmatic process, it has become clear that geochemistry of radiation-damaged zircon may be variably altered by post-emplacement processes involving aqueous fluids (e.g., Valley et al., 1994, 2015; Cavosie et al., 2005; Wang et al., 2014; Pidgeon et al., 2019; Liebmann et al., 2021). Exchange by diffusion during ultra-high-temperature metamorphism ($>900^\circ\text{C}$) has also been described (Watson and Cherniak, 1997; Claesson et al., 2016),

although such exchange has not been observed in zircons metamorphosed to granulite facies at more normal temperatures (Page et al., 2007, Bowman et al., 2011). Thus, careful characterization of alteration coupled with spatially integrated geochemical observations within zircon grain domains is critical for constructing a geologically meaningful record of the oldest crust.

Here, we present zircon oxygen isotope systematics from a suite of granitic gneisses exposed in one of the oldest known crustal fragments, the Saglek-Hebron Complex of the North Atlantic Craton, which includes rocks approaching 3.9 Ga in age. Previous investigation of metamorphic zircons from two Eoarchean-Paleoarchean meta-igneous rocks in this locality indicated the presence of high (+9 ‰) metamorphic zircon oxygen isotope ratios at ~3.5 Ga, making this locality an intriguing place to investigate early crustal reworking (Vezinet et al., 2018; 2019; 2022). By targeting igneous zircon domains that were previously characterized by paired U-Pb and Lu-Hf isotopes (Wasilewski et al., 2021) and by correlating this information with insights from geochemical indicators of hydrous alteration and Raman spectroscopy, we construct a temporally comprehensive view of how and when igneous melts interacted with low-temperature altered material to form continental crust in the SHC. Observations from this well-characterized terrane allow us to interrogate the possible mechanisms for introducing supracrustal lithologies to crustal melting depths in the Archean.

2.0 Geologic Overview

The Saglek-Hebron Complex (**Fig. 1**) is a polymetamorphic terrane that forms the northern block of the Nain Province of the North Atlantic Craton. The complex hosts rocks representing an extended period of crustal growth spanning over 1.5 billion years (~3.9 – 2.7 Ga, e.g., Komiya et al., 2017; Vezinet et al., 2018; Wasilewski et al., 2021). The SHC is dominated by tonalite-trondhjemite-granodiorite (TTG) orthogneisses, which include meter- to kilometer-scale enclaves of supracrustal metasediments and mafic rocks. The supracrustal mafic rocks mostly consist of meta-basalts interpreted to represent tholeiitic metavolcanic rocks, interlayered with detrital and chemical metasedimentary rocks (Nutman et al., 1989; Schiøtte et al., 1992; Wasilewski et al., 2019). The SHC also includes ultramafic bodies, which have been

interpreted as meta-komatiites, fragments of lithospheric mantle and/or ultramafic cumulates genetically linked to the meta-basaltic rocks (e.g., Collerson et al., 1991; Morino et al., 2017; Wasilewski et al., 2019). The age for the mafic-ultramafic rocks has been constrained from various isotopic systems such as Sm-Nd, Lu-Hf and Re-Os (Collerson et al., 1991; Ishikawa et al., 2017; Morino et al., 2017; 2018). Although these ages are relatively imprecise, it appears that the oldest Nulliak supracrustal assemblage is inferred to have formed in the Eoarchean (~3.8 Ga), followed by a the younger Upernavik Paleoproterozoic (~3.4 Ga) assemblage. Recent zircon U-Pb and Lu-Hf work on the SHC felsic gneisses has refined the chronology for six magmatic generations emplaced at 3.87, 3.75, 3.63, 3.33, 3.22, and 2.79 Ga, respectively referred to as Iqaluk, Uivak I, Uivak II, Iluilik, Lister and late granite events (Wasilewski et al., 2021). Two distinct metamorphic events have affected the crustal rocks following their emplacement: (1) a ~3.5 Ga event following the 3.6 Ga Uivak II magmatic generation, resulting in the development of migmatite and growth of metamorphic zircon (e.g., Sałacińska et al., 2018; Vezinet et al., 2018; 2019; 2022; Wasilewski et al., 2021), and (2) a granulite-facies metamorphic event that generated peak granulite facies metamorphic conditions for the complex at ~2.7 Ga, contemporaneous with volumetrically significant granitic magmatism (e.g., Schiøtte et al., 1989b, Van Kranendonk, 1990, Komiya et al., 2015; Kusiak et al., 2018; Wasilewski et al., 2021). Following Neoproterozoic magmatism, the Proterozoic Torngat Orogen (~1.8 Ga) resulted in both brittle deformation and extensive reworking of the Archean gneisses (Bridgewater et al., 1975; Van Kranendonk, 1996). Although these events have deformed the basement rocks which are the focus of our work, we follow the convention of Wasilewski et al. (2021) in their initial description of the samples used in this study, using ‘granitoid’ as an interpretive simplification for broadly describing the felsic plutonic rocks of the SHC.

Extensive whole-rock geochemical, petrographic, and isotopic characterization of the ~3.9-2.7 Ga felsic rocks in the SHC provides a framework for further geochemical exploration of the mechanisms that formed this early crust (Wasilewski et al., 2021). Zircon Hf and whole-rock $^{142}\text{Nd}/^{144}\text{Nd}$ isotope ratios indicate crustal growth at ~3.87 Ga and remelting of a Hadean-age mafic proto-crust throughout the

Paleoarchean, followed by a brief and highly localized juvenile melt source circa 3.22 Ga, and a suite of Neoarchean granites that formed largely at the expense of Eoarchean TTGs (Wasilewski et al., 2021; 2022). Elevated $\delta^{18}\text{O}$ (+9 ‰) values documented within ~3.5 Ga metamorphic zircons from a granitic gneiss have been interpreted to indicate volumetrically significant reworking of mature supracrustal rocks, but zircon oxygen isotope investigation has thus far been relatively limited to the 3.8-3.5 Ga granitoids and select detrital zircons from metasedimentary units (Vezinet et al., 2018; 2019; 2022). To further constrain the timing and character of supracrustal contributions to felsic melts throughout the Archean in the SHC, we focus on suites of cogenetic igneous zircon from seven individual granitoids representative of the six magmatic generations defined by Wasilewski et al. (2021).

3.0 Methods

3.1 Grain Selection and Imaging via SEM

Oxygen isotope analyses were targeted within individual domains interpreted as crystalline igneous zircon based on (1) oscillatory growth zoning and non-metamict or broad band sectored zones in CL and (2) concordant (mostly >95%) U-Pb and Pb-Pb dates interpreted as igneous crystallization ages by Wasilewski et al. (2021). Circa 2.8-2.7 Ga metamorphic zircon rims from tonalite SG-027 and trondhjemite SG-122 were also analyzed for comparison to grain cores. The Th/U of targeted igneous grains are mostly ~0.2 to 1.8, while select domains with metamorphic ages (3.6-3.5 Ga rims/domains on Eoarchean zircons, 2.7-2.8 Ga rims/domains on Paleoarchean zircons) have values $\ll$ 0.1 (Wasilewski et al., 2021; **Fig. 3, Supplemental Table S1**). To prepare for SIMS analysis, zircon reference material UWZ1 was top-mounted into the grain mounts that previously underwent U-Pb and Hf isotope analyses. The mounts were repolished for flatness, and grain images were compared to Wasilewski et al. (2021) to ensure that target domains had not changed significantly upon regrinding/polishing. Cathodoluminescence (CL) and backscattered-electron images (BSE) were used to characterize internal zircon structures and identify and avoid areas of alteration in all grains targeted for oxygen isotope analysis. This work was completed in the University of Wisconsin-Madison (UW-Madison) Ray and Mary Wilcox SEM lab, using a Hitachi S3400N Scanning

Electron Microscope (SEM). Representative zircons from each granitoid are shown in **Figure 3** and all grain images are included in **Supplemental Materials**. In addition to pre-analysis imaging, post-analysis secondary electron and backscattered electron images of SIMS $\delta^{18}\text{O}$ pits were used to identify analyses that intersected with fractures or inclusions.

3.2 Oxygen Isotopes and Trace Elements in Zircon via SIMS

In-situ zircon oxygen isotope analysis was completed using the large-radius double-focusing CAMECA IMS 1280 Secondary Ion Mass Spectrometer (SIMS) in the WiscSIMS laboratory at UW-Madison using a $^{133}\text{Cs}^+$ primary beam. Ions of $^{18}\text{O}^-$, $^{16}\text{O}^{1}\text{H}^-$ and $^{16}\text{O}^-$ were simultaneously collected by three Faraday Cup detectors (Kita et al., 2009; Valley and Kita, 2009; Wang et al., 2014). Regular analysis of a zircon running standard (UWZ1, $\delta^{18}\text{O} = +4.98\text{‰}$, VSMOW, Valley, pers. comm, 2023) was used to quantify instrumental mass bias, monitor instrument stability, correct for background OH, and quantify the reproducibility of $\delta^{18}\text{O}$ measurements. Four consecutive $\delta^{18}\text{O}$ zircon (UWZ1) measurements were made before and after every 10-15 sample zircon $\delta^{18}\text{O}$ measurements. Twice the standard deviation of the eight bracketing standards is taken as the precision (reproducibility) of the bracketed unknowns. Average analytical precision for $\delta^{18}\text{O}$ in our dataset is 0.2 ‰ (2 SD). The results of all oxygen isotope data are reported in **Supplemental Tables S3 and S4**.

Trace elements were measured in the WiscSIMS facility on the CAMECA IMS 1280. Analyses targeted many of the same domains analyzed for age, and Hf isotopes (Wasilewski et al., 2021), and $\delta^{18}\text{O}$ (this study). Trace element analyses used a $\sim 5.5\text{ nA }^{16}\text{O}^-$ primary beam, with a pit diameter of $\sim 13\text{ }\mu\text{m}$. The mass spectrometer was operated at a nominal mass resolving power of $M/\Delta M = 14000$, sufficient to resolve major interferences for analyzed species. Each analysis included a pre-sputter, followed by automated centering of the secondary beam, and five counting cycles from low to high mass. Count rate data were normalized to $^{28}\text{Si}^+$ and converted to concentrations based on element specific relative sensitivity factors (RSFs). RSFs were based on NIST610 (Pearce et al., 1997) as a primary standard; the glass-zircon matrix difference is accounted for using element specific correction factors based on secondary reference materials

91500 (Wiedenbeck et al., 2004; Coble et al., 2018), MAD559 (Coble et al., 2018), and GZ7 (Nasdala et al., 2018). Additional details can be found in (Blum et al., 2023).

3.3 Screening for Altered Zircon

Zircon domains for oxygen isotope analysis were evaluated by multiple tests, including zoning patterns by CL and BSE, U-Pb age concordance, trace elements (Ca, Al, Fe, La), Raman spectroscopy, and OH/O. Other studies have demonstrated that values of background-corrected $^{16}\text{OH}/^{16}\text{O}$ (OH/O hereafter) correlate positively with these other indicators of alteration, such as elevated concentrations of non-formula elements in zircon (e.g., Al, Ca, Fe, LREEs), radiation damage state, and recrystallization textures (Wang et al., 2014; Valley et al., 2015; Pidgeon et al., 2019; Liebmann et al., 2021). Background-corrected OH/O was calculated following Wang et al., (2014), and is corrected relative to OH/O measured on a nominally anhydrous SIMS zircon running standard (UWZ1). Background corrected OH/O and ranges from -4×10^{-5} to 2×10^{-3} for our dataset. The OH/O background varies with vacuum pressure, which changes systemically over time, as well as on a sample-to-sample and session-to-session basis (Wang et al., 2014; Pidgeon et al., 2019; Liebmann et al., 2021). Regular bracketing of OH/O ratios on running standards proved a robust means to track and correct OH/O backgrounds over the course of hours-days (Wang et al., 2014). The background corrected OH/O ratios measured here are not a quantitative measure of water, but represent an internally consistent, relative measure of elevated water content. In our dataset, analyses with OH/O > 0.0002 are considered unreliable as this is the value above which we see increased within-sample variability of zircon $\delta^{18}\text{O}$, and elevated correlated Al-Ca-Fe concentrations, indicative of geochemical modification (**Fig. 4**).

Of our 271 oxygen isotope analyses, 33 record OH/O > 0.0002. The majority (28/33) of analyses with elevated OH/O coincide with irregularities identified during post-analysis imaging of the analytical pits, such as inclusions or cracks, suggesting that most of the visibly intact zircons in our study have OH/O < 0.0002. Zircon domains where both O-isotope and trace-element data were obtained were screened at a 20 ppm threshold for Ca, Fe, and Al (**Fig. 4b-d**). These thresholds are conservative compared to

common cutoffs of Ca and Fe > 50-100 ppm (e.g., Grimes et al., 2015; Drabon et al., 2021, 2022). Thirty domains targeted for oxygen isotope measurements were identified as likely to be altered based on spatially correlated TE data. Of these, 5/30 display both elevated OH/O and Ca, Fe, or Al > 20 ppm, and 7/30 analyses pass all other metrics but record Fe > 20 ppm. Of our 271 zircon $\delta^{18}\text{O}$ analyses, 208 meet all pit imaging, OH/O and Ca-Fe-Al criteria (**Fig. 4**).

3.4 Raman Spectroscopy and α -Dose Calculations

The frequency and bandwidth of the SiO_4 stretching mode (ν_3) in the zircon Raman spectrum has been empirically correlated with zircon structural state and damage accumulation (Nasdala et al., 2001; Palenik et al., 2003). To investigate the current damage state of SHC zircons, we performed Raman spectroscopy at 1 bar adjacent to SIMS oxygen isotope pits on a sub-set of grains representing a range of ages, CL textures, and zircon $\delta^{18}\text{O}$ in the SHC. Raman spectroscopic analysis was completed using a LabRAM HR Evolution Raman system at UW-Madison. Raman spectra were collected using an excitation wavelength of 633 nm, 100x objective, and 1800 groove/mm grating. Both the confocal hole and spectrometer entrance slit were set at 100 μm . Under these conditions, spatial resolution is approximately 2.5 μm^3 and spectral resolution is $<0.5 \text{ cm}^{-1}$. Calibration of the spectrometer was completed using the 520.7 cm^{-1} Raman band on a reference Si wafer. On average, three to six Raman spectra were collected for the $\nu_3(\text{SiO}_4)$ mode correlated spatially to each $\delta^{18}\text{O}$ pit. Spectral processing was completed using the Horiba Scientific LabSpec6 software for background subtraction and fitting using a combined Gauss-Lorentz peak shape function. Measured bandwidths were corrected for the apparatus function following Vaczi (2014). Raman data are tabulated in **Supplemental Table S2**. Effective doses (D_{eff}), which represent the amount of radiation damage preserved in a zircon at time of measurement, were calculated based on the band-broadening trends of Palenik et al. (2003):

$$D_{\text{eff}} = -\frac{1}{B} \ln\left[1 - \frac{FWHM_{\nu_3(\text{SiO}_4)}}{A}\right] \quad (1)$$

where A is the asymptotically approached maximum FWHM value, B_{FWHM} is related to the mass of material damaged per decay event, and D_{ed} is the equivalent dose. The total dose (D_{total}), which is the total α -radiation experienced by a zircon since crystallization, can be calculated for a given U and Th content at a given zircon age (Ewing et al., 2003; Palenik et al., 2003):

$$D_{total} = 8N_1[\exp(\lambda_1 t) - 1] + 7N_2[\exp(\lambda_2 t) - 1] + 6N_3[\exp(\lambda_3 t) - 1] \quad (2)$$

where N_1 , N_2 , and N_3 are the concentrations of ^{238}U , ^{235}U , and ^{232}Th , respectively, in atoms/mg; λ_1 , λ_2 , and λ_3 are the decay constants for ^{238}U , ^{235}U , and ^{232}Th , respectively, in years $^{-1}$; and t is the age of the zircon. Total dose calculations were performed for all zircons from all seven granitoids using U and Th concentrations and ages from Wasilewski et al. (2021). In many natural zircon grains, values of D_{eff} are lower than D_{total} due to annealing.

4.0 Results

4.1 Zircon O Isotopes by SIMS

We performed 271 oxygen isotope analyses on 108 zircons from seven granitoids spanning 3.87 to 2.79 Ga (**Fig. 5, Table 1, Supplemental Tables S1, S3, and S4**). Of these, 208 analyses pass screening criteria based on pit imaging, background corrected OH/O, and Ca-Al-Fe, as discussed above. All domains are >95% concordant in age (Wasilewski et al., 2021). Additionally, no strong trends are observed between zircon $\delta^{18}\text{O}$ and Th/U ratio (**Supplemental Figure S1**). In analyses that pass screening, we observe mantle-like to mildly elevated $\delta^{18}\text{O}$ values for the Eoarchean (3.87 to 3.78 Ga Iqaluk and Uivak I units) zircons studied, with sample weighted mean zircon $\delta^{18}\text{O}$ ranging from $+5.47 \pm 0.03$ (2 SE) to $+6.42 \pm 0.03$ (2 SE) ‰ (zircons from granitoid samples SG-210c, SG-026, SG-122). These are followed by higher $\delta^{18}\text{O}_{VSMOW}$ with weighted mean zircon $\delta^{18}\text{O}$ of $+8.12 \pm 0.06$ (2 SE) ‰ in the Uivak II unit at ~3.63 Ga (tonalite SG-

027). Maximum igneous zircon $\delta^{18}\text{O}$ observed in zircon from this tonalite is 8.4 ± 0.2 (2 SD) ‰ (grain D17, Th/U = 0.29). Zircon $\delta^{18}\text{O}$ values for the 3.33 Ga Iluilik and 2.79 Ga late granite magmatic generations are elevated relative to mantle-like values (sample weighted-mean zircon $\delta^{18}\text{O}$ of $+7.77 \pm 0.04$ ‰ and $+6.73 \pm 0.15$ ‰ for SG-203 and SG-127, respectively). The 3.22 Ga Lister Gneiss unit (represented by tonalite SG-265) represents a short-lived contribution from a juvenile magmatic source based on Hf isotopic data (Wasilewski et al., 2021) and is also characterized by mantle-like zircon $\delta^{18}\text{O}$ values (sample weighted-mean zircon $\delta^{18}\text{O}$ of $+5.68 \pm 0.03$ ‰). Young metamorphic rims on zircons from tonalite SG-027 and trondhjemite SG-122 (rim U-Pb ages 2.7-2.8 Ga) vary in $\delta^{18}\text{O}$ by ± 0.1 to 0.6 ‰ from the isotope ratios of their older cores. While zircon $\delta^{18}\text{O}$ varies by > 3 ‰ between granitoids, zircons from the same age population within a given granitoid vary by $< \pm 0.5$ ‰ within each of the granitoids.

4.2 Trace Elements in Zircon by SIMS

We performed 135 trace element analyses on 108 zircons from seven granitoids with ages spanning 3.87 to 2.79 Ga (**Fig. 6, Supplemental Table S5**). All 108 zircons targeted for trace element analysis were also characterized by U-Pb, Lu-Hf (Wasilewski et al., 2021) and zircon $\delta^{18}\text{O}$ (this study). Of the 135 domains analyzed for trace-elements, 90 pass screening criteria based on pit imaging, background-corrected OH/O, and Ca-Al-Fe, as discussed above. For analyses that pass screening, we observe chondrite-normalized (McDonough and Sun, 1995) rare earth element (REE) patterns with light REE depletion, heavy REE enrichment, and negative Eu and positive Ce anomalies across all unaltered domains (solid lines in **Fig. 6**). Analyses of domains that did not pass Ca, Al, Fe, or OH/O screening metrics are shown as dashed lines. Many of these flagged domains also display high La concentrations and no Ce anomaly, traits which can also correlate with alteration (e.g., Bell et al., 2016).

4.3 Raman Spectroscopy and α -Dose Calculations

We collected 319 Raman spectra (~3 Raman spectra for every domain targeted by SIMS for $\delta^{18}\text{O}$) for all grains from the oldest sample in the suite, ~3.87 Ga tonalite SG-210c, as well as from the two

granitoids with the highest zircon $\delta^{18}\text{O}$ values: ~3.63 Ga tonalite SG-027, and ~3.33 Ga granodiorite SG-203. Most FWHM values of SG-210c and SG-203 fall below 15 cm^{-1} , while most analyses of SG-027 extend between 15 and 30 cm^{-1} (**Fig. 7a, Supplemental Table S2**). Effective doses were calculated based on the band-broadening trends (**Equation 1**) of Palenik et al. (2003). All data for SG-210c and SG-203 fall well below the first percolation point, while 60 % of the grain cores analyzed in SG-027 extend above $2 \times 10^{15}\text{ }\alpha\text{-decays/mg}$ (**Fig. 7b**). In complement to this data collection, we calculated total doses ($\alpha\text{-decays/mg}$) using **Equation 2** with Th and U concentrations and ages from Wasilewski et al. (2021) for all grains across all samples (**Supplemental Figures S2, S3**). Calculated total dose values range from 1×10^{15} to $3 \times 10^{16}\text{ }\alpha\text{-decays/mg}$, with most doses less than 5×10^{15} .

5.0 Discussion

5.1 Are Zircon $\delta^{18}\text{O}$ Values in the Saglek-Hebron Complex Granitoids Primary?

Ultra-high temperature ($> 900\text{ }^{\circ}\text{C}$) metamorphic conditions have been proposed to alter zircon oxygen isotope ratios by diffusion without significantly affecting U-Pb/Hf isotope systematics or preservation of primary igneous CL textures (e.g., Claesson et al., 2016). However, questions about the mechanisms and efficacy of high-temperature diffusion remain, with both experimental and natural data demonstrating that undamaged crystalline zircons can retain primary geochemistry when exposed to high temperatures under fluid-absent conditions. This indicates that high temperatures alone do not generate sufficiently rapid diffusion to wholly reset oxygen isotopes in pristine zircon (e.g., Watson and Cherniak, 1997; Page et al., 2007; Bowman et al., 2011). It has been proposed that oxygen isotope diffusion rates are faster in the presence of water and thus that alteration can occur when aqueous fluids are present during metamorphism (e.g., Watson and Cherniak, 1997; Cherniak and Watson, 2003; Geisler et al., 2007). However, measurements of zoned, granulite-facies zircons (Page et al., 2007; Bowman et al., 2011) and recent experiments (Bindeman et al., 2018) are not in accord with ‘fast’ wet diffusion rates.

The possibility of ultra-high temperature diffusion in crystalline zircon notwithstanding, numerous studies have documented that damage to the zircon structure via alpha decay is a far more common agent

for facilitating geochemical alteration (Murakami et al., 1991). Damage from self-irradiation can result in both point defects and amorphous regions within the crystal structure, leaving grains susceptible to subsolidus alteration or dissolution-reprecipitation (e.g., Hoskin, 2005; Geisler et al., 2007). In the case of this study, radiation damage is a more likely candidate process for alteration in SHC zircon than UHT diffusion, as peak metamorphic conditions are interpreted to be granulite facies with no UHT conditions reported (e.g., Schiøtte et al., 1989b; Komiya et al., 2015; Kusiak et al., 2018). Interpretation of $\delta^{18}\text{O}$ values in zircons from rocks, such as SG-027, that have populations of zircon with high cumulative radiation dosages, therefore requires consideration of multiple parameters to validate primary compositions. Investigating geochemical indicators of hydration and element mobility (**Fig. 4**) and crystalline damage (**Fig. 7**) can help identify zircon domains that have low degrees of radiation damage that preserve primary oxygen isotope information. In the case of coherent crustal segments like the SHC, comparison of zircon oxygen isotope variability within and between lithologic units can lend information about post-emplacement alteration. For example, resetting of zircon $\delta^{18}\text{O}$ via fluid-mediated recrystallization could be expected to increase zircon $\delta^{18}\text{O}$ variability within individual granitoids, while widespread resetting might generate a shared maximum zircon $\delta^{18}\text{O}$ value across multiple units.

Multiple geochemical filters for secondary chemical modification (OH/O and Al-Ca-Fe) are consistent with 77% of our oxygen isotope data were being unaffected by radiation-damage enhanced hydration or element mobility – i.e., are primary crystallization $\delta^{18}\text{O}$ values. This conclusion is supported by unit-to-unit $\delta^{18}\text{O}$ differences and within-unit homogeneity of zircon $\delta^{18}\text{O}$ values when data are geochemically screened. We observe zircon-to-zircon oxygen isotope homogeneity within the oldest granitoids and lower $\delta^{18}\text{O}$ values than those recorded by Paleoproterozoic rocks; we find it highly unlikely that indicating that any fluids associated with the high- $\delta^{18}\text{O}$ 3.63 Ga magmatic event uniquely altered all the Eoarchean zircons equally to a single, homogeneous value, and we take the homogeneity of these populations as evidence of preservation of primary $\delta^{18}\text{O}$ compositions. Furthermore, we observe mantle-like zircon $\delta^{18}\text{O}$ values in the 3.22 Ga tonalite SG-265, bracketed temporally by magmatic generations with above-mantle values (**Fig.**

8), indicating that any inferred fluids associated with the 2.79 Ga event also did not wholly overprint the zircon oxygen isotope record. Neoarchean rims on zircons from Eoarchean trondhjemite SG-122 and Paleoproterozoic tonalite SG-027 have zircon oxygen isotope ratios that overlap with their respective cores (within 0.1 ‰ of cores for SG-027 and within 0.6 ‰ for SG-122). This result differs from previous reports of > 2 ‰ differences between Paleoproterozoic cores and Neoarchean rims in other rocks from the SHC (Vezinet et al., 2019). In our dataset, the oxygen isotope ratios of Neoarchean rims on zircons from older granitoids are closer to their primary Eoarchean and Paleoproterozoic cores in $\delta^{18}\text{O}$ than to the Neoarchean cores of granite SG-127 (**Table 1**). We interpret this to indicate that Neoarchean rims of our study dominantly represent dissolution and regrowth of older cores during the ~2.8 Ga magmatic event, while the Neoarchean zircon rims of the Vezinet et al. (2019) study variably record the exogenous component contemporaneous with the magmatism. Although the seven granitoids in this study are part of a single, long-lived terrane, the complex history of rocks of this age means that a more careful consideration of the independent context of each lithologic unit is warranted when interpreting the O isotope record.

Comparing multiple alteration criteria for several of the SHC magmatic generations, we conclude that screened zircon $\delta^{18}\text{O}$ values are primary to the magmas from which zircon crystallized. The three samples targeted for Raman analysis, SG-210c, SG-027, and SG-203, represent a wide range of CL textures and ages (3.87 to 3.33 Ga) of SHC zircon and include the full range of zircon $\delta^{18}\text{O}$ values (+5.0 to 8.4 ‰) present in our larger dataset. Of the seven granitoids we studied, the 3.63 Ga cores from the Uivak II tonalite SG-027 record the highest zircon $\delta^{18}\text{O}$ (+7.9 to 8.4 ‰), but also yielded background-corrected OH/O values close to our cutoff of 0.0002. Additionally, zircon CL textures from this granitoid display darker and more faint sector zoning (**Fig. 3**), possibly indicating radiation damage. This contrasts with the more classic oscillatory zoning observed in zircons from the 3.87 Ga Iqaluk tonalite SG-210c (mantle-like $\delta^{18}\text{O}$) and the 3.33 Ga Iluikil granodiorite SG-203 (+7.2 to 8.2 ‰ igneous $\delta^{18}\text{O}$). Raman spectroscopic characterization of the grains from Uivak II tonalite SG-027 reveal more significant band broadening (**Fig. 7a**) and higher effective dose values (**Fig. 7b**) than those observed for zircons from SG-203 and SG-210c. A majority of

the domains analyzed in zircons from SG-027 plot above the first percolation point, at which the grain is 30-40 vol.% amorphous and damaged domains overlap to form continuous pathways for rapid exchange (Ewing et al., 2003). These observations, when integrated with information from Raman and OH/O, indicate that most of the zircons with high $\delta^{18}\text{O}$ values in SG-027 are presently more open to exchange than zircons from other SHC granitoids. Despite the greater degree of radiation damage as characterized by Raman, the low grain-to-grain variability in zircon $\delta^{18}\text{O}$ for SG-027 and lack of correlation between effective dose and zircon $\delta^{18}\text{O}$ (**Fig. 7b**) indicates that these zircons likely preserve primary $\delta^{18}\text{O}$ in excess of +8 ‰. If later fluids were present, the fluid-rock ratio during post-emplacement events was either not high enough to alter O isotope compositions, or the zircon was buffered by a similar value of $\delta^{18}\text{O}$ as the original rock. Additionally, there is strong evidence that both mantle-like oxygen isotope values (SG-210c) and values > +8 ‰ (SG-203) can be readily preserved in less-damaged primary igneous zircon despite multiple post-emplacement metamorphic events.

Our highest igneous zircon $\delta^{18}\text{O}$ values for 3.63 Ga and 3.33 Ga SHC granitoids are lower than previously published high- $\delta^{18}\text{O}$ (+9 ‰, Vezinet et al., 2019) values from a population of ~3.5 Ga metamorphic zircons in a ~3.6 Ga granitoid (**Fig. 8c**), which were screened using a combination of U-Pb concordance and select trace-element concentrations (Ca, La, Ba). In comparison, screening of our 3.63 Ga zircon $\delta^{18}\text{O}$ sample (tonalite SG-027) using age concordance >95%, CL imagery, OH/O, Al-Ca-Fe composition, yields a weighted mean $\delta^{18}\text{O}$ value of $+8.12 \pm 0.06$ (2 SE) ‰ for primary igneous zircon circa 3.6-3.7 Ga. Retention of both elevated and mantle-like primary $\delta^{18}\text{O}$ in many zircons is supported by our Raman analysis of zircons representing the range of oxygen isotopes recorded in our dataset. Our screening methods support the interpretation that igneous zircon $\delta^{18}\text{O}$ values up to +8.1 ‰ in the SHC zircon reflect incorporation of supracrustal material into crustal melts during both the 3.63 Ga Uivak II and 3.33 Ga Illuilik magmatic events (**Table 1**). This result is consistent with zircon oxygen isotope observations from meta-igneous and meta-sedimentary rocks which imply that reworking of supracrustal material was widespread in the SHC by the Paleoproterozoic (Vezinet et al., 2018; 2019; 2022).

5.2 Geodynamic Implications from Correlated Hf, Nd, and O Isotopes

The preservation of multiple generations of evolved magmas in the SHC presents an opportunity to interrogate the evolution of crustal production and supracrustal recycling on the early Earth. Information from zircon O and Hf isotopes and whole-rock $^{142}\text{Nd}/^{144}\text{Nd}$ for samples with ages between 3.87 and 2.79 Ga constrains the potential geodynamic regime(s) that operated during the formation of the SHC (**Table 1**, **Fig. 8**, Wasilewski et al., 2021; 2022, Vezinet et al., 2018, 2019, 2022). To resolve Hf and Nd isotopic evidence for fluctuating contributions from juvenile and evolved magmatic sources throughout the Archean, Wasilewski et al. (2021, 2022) suggest that tectonic imbrication of a thickened oceanic crust could have allowed multiple magmatic sources to interact and melt crust of varying ages across the distinct SHC felsic generations. This sequential stacking and reworking of imbricated crustal slices via lateral thickening, or ‘subcretion’, has been similarly invoked to explain other isotopic observations in the Archean, including elsewhere in the North Atlantic Craton (e.g., Barr et al., 1999; Hacker et al., 2015; Nutman and Bennett, 2019). Existing zircon oxygen isotope data for metamorphic and detrital zircon from the SHC further require that this imbrication must have involved hydration and burial of supracrustal material during at least the ~3.5 Ga magmatic event (Vezinet et al., 2019, 2022).

Our significant expansion of the zircon oxygen isotope record in Saglek-Hebron allows detailed correlation of isotopic information and increased insight into multiple phases of crustal reworking between 3.87 and 2.79 Ga. The oldest Iqaluk and Uivak I TTGs (3.9-3.7 Ga) record juvenile zircon ϵ_{Hf} (+1.7 to +3.7); **Table 1**, **Fig. 8a**), supra-chondritic initial ϵ_{Nd} between +3 and +4 (Wasilewski et al., 2022), and have positive $\mu^{142}\text{Nd}$ anomalies (+14.9 to +7.4; **Table 1**, **Fig. 8b**), consistent with magma genesis involving re-melting of ~3.8-3.9 Ga mafic crust sourced from an early depleted mantle (Wasilewski et al., 2021; 2022). The zircon $\delta^{18}\text{O}$ values for these units (SG-210c, SG-026, SG-122, **Table 1**, **Fig. 8c**) are slightly elevated (+5.5 to 6.4 ‰) relative to mantle-like values, indicating that the mafic precursor crust to the Eoarchean granitoids may have undergone a minor degree of low-temperature alteration before re-melting to form the TTG. Based on unradiogenic zircon ϵ_{Hf} (-1.1 to -6.3; **Fig. 8a**) and whole-rock geochemistry of the 3.63 Ga Uivak II and 3.33 Ga Iluilik TTG, these two magmatic generations were interpreted as indicative of

reworking of older, perhaps Hadean, crustal mafic material (Wasilewski et al., 2021). The elevated zircon $\delta^{18}\text{O}$ values recorded during the 3.63 Ga Uivak II (average = 8.1 ‰) and the 3.33 Ga Iluilik (average = +7.8 ‰) magmatic events suggest a greater incorporation of low-temperature altered material in the crustal source of the Paleoarchean TTG (**Fig. 8c**). Zircon $\delta^{18}\text{O}$ values are homogeneous and mantle like (+5.4 to 5.9 ‰) during the emplacement of the juvenile 3.22 Ga Lister Gneiss but are elevated (average = +6.7 ‰) in 2.7-2.8 Ga “Late Granite” magmas from the SHC, where zircon again records more unradiogenic ϵ_{Hf} coupled with positive whole-rock $\mu^{142}\text{Nd}$ anomalies (**Fig. 8b**).

In the SHC, juvenile crustal growth events with mantle-like zircon $\delta^{18}\text{O}$ alternate through time with reworking events that record more elevated $\delta^{18}\text{O}$ values in tandem with zircon Hf and whole-rock Nd indicators of crustal recycling (**Fig. 9**). The near-chondritic ϵ_{Hf} for zircons of samples SG-026, SG-210c, SG-122 and SG-265 suggest a relatively juvenile source compared to samples SG-027, SG-203 and SG-127, which record lower ϵ_{Hf} values consistent with an older crustal precursor. The relationship between zircon ϵ_{Hf} and $\delta^{18}\text{O}$ values (**Fig. 9**), therefore, suggests that incorporation of low-temperature altered material was more important for granitoids sourced from an older crustal precursor compared to TTG with more juvenile ϵ_{Hf} displaying mantle-like $\delta^{18}\text{O}$. While zircon $\delta^{18}\text{O}$ alone cannot distinguish secular trends in crustal genesis, the emergence of a strong correlation of zircon oxygen isotope values with patterns in radiogenic isotopes can lend additional information about the character of early crustal reworking events. Correlated Hf-Nd-O isotope systematics therefore place several constraints on local geodynamic setting: (1) early juvenile crustal production, (2) long residence times of Hadean and Eoarchean components that remain accessible for re-melting during later magmatic events, (3) Eoarchean-Paleoarchean low-temperature alteration, weathering, or diagenesis of surface material, and (4) effective burial and reworking of this low-temperature (< 150 °C) altered surface material with limited inputs from juvenile material during multiple magmatic events < 3.6 Ga. Although localized to the SHC, these integrated observations span over a billion years (~3.8 to 2.8 Ga) and are consistent with geodynamic models that invoke episodic juvenile crustal growth and isolated or diachronous reworking of long-lived Hadean crustal material in multiple

terrane throughout the Archean (e.g., Kemp et al., 2010; Pietranik et al., 2014; Rosas and Korenaga, 2018; Reimink et al., 2019).

5.3 Mechanisms for Generating High- $\delta^{18}\text{O}$ Zircon in Archean Magmas

Although mildly elevated $\delta^{18}\text{O}$ values (+6 to 7 ‰) have now been recognized as making up nearly 50% of the global Archean igneous and metamorphic zircon record (Valley et al., 2005; Spencer et al., 2022; Vezinet et al., 2022), excursions $> +7$ ‰ are rare before ~ 2.5 Ga (e.g., Valley et al., 2005; Spencer et al., 2022). Given that $\delta^{18}\text{O}$ fractionation is governed by temperature, mildly elevated zircon $\delta^{18}\text{O}$ values cannot distinguish between processes such as assimilation of altered volcanic rocks or small-volume incorporation of sediments or hydrated oceanic crust. Therefore, questions remain about the prevalence and mechanisms of supracrustal incorporation into melts in early Earth magmatic systems. The secular shift toward juvenile zircon ϵ_{Hf} in many Archean terranes has been previously interpreted to record an increase in volume or change in mechanism of crustal production between 3.8-3.6 Ga or at 3.2 Ga (e.g., Naeraa et al., 2012; Bauer et al., 2020; Wasilewski et al., 2021; Drabon et al., 2022). The onset of a more efficient mobile-lid regime may have increased the transport and burial of shallow, cool, and hydrated supracrustal material to depth. However, the prevalence of mantle-like to mildly elevated zircon $\delta^{18}\text{O}$ values in the Archean indicates that there is no significant global increase in the input of surface-altered high- $\delta^{18}\text{O}$ material into Archean magmatic systems (e.g., Valley et al., 2005; Spencer et al., 2022; Drabon et al., 2022). Instead, the widespread rise in zircon $\delta^{18}\text{O}$ that occurs at the Archean-Proterozoic boundary (e.g., Valley et al., 2005) has been variably attributed to a change in sediment composition, weatherability, and efficiency of tectonic burial (Valley et al., 2005; Bucholz and Spencer, 2019; Bindeman et al., 2018; 2021; Iaccheri et al., 2018; Payne et al., 2015).

Primary zircon domains from this study associated with magmatic events at 3.63, 3.33, and 2.79 Ga in the SHC preserve zircon $\delta^{18}\text{O} > +7$ ‰ (**Fig 8c**), beyond what can be produced by crystal fractionation processes alone (e.g., Valley et al., 2005; Bucholz et al., 2017) and thus provide strong evidence for significant incorporation of high- $\delta^{18}\text{O}$ supracrustal material into crustal melts during multiple magmatic

generations beginning in the Paleoarchean at this locality. Recent work delineating a new minimum depositional age > 3.65 Ga and possible convergent-margin depositional setting for the Nulliak supracrustal assemblage (Vezinet et al., 2022) allow for these supracrustal mafic and metasedimentary rocks as a possible candidate source for generating high-zircon $\delta^{18}\text{O}$ values during magmatic events < 3.6 Ga. While whole-rock O-isotope data have not been thoroughly investigated for these possible assimilants, this supracrustal assemblage has been observed as enclaves in the high- $\delta^{18}\text{O}$ orthogneisses (granitoids), and $\delta^{18}\text{O}$ up to +8 ‰ (Kutyrev et al., 2023) has been measured, consistent with the geochronologic constraints of Vezinet et al (2022). This assemblage has been previously interpreted as an Eoarchean accretionary complex (Komiya et al., 2015), with multiple lithologies likely to have relatively high $\delta^{18}\text{O}$ compositions, including metapelitic schists, basaltic metavolcanics, and chemical metasedimentary rocks (e.g., Bridgwater et al., 1975). However, the mechanisms by which repeated mass transfer occurs between these weathered components and crustal melts in subsequent 3.63, 3.33 and 2.79 Ga magmatic events remain unknown. This transfer could occur either via widespread assimilation of elevated- $\delta^{18}\text{O}$ supracrustal material into juvenile magmatic systems, or through partial melting of intercalated weathered igneous and sedimentary lithologies buried to depth. While both scenarios are plausible, existing zircon Hf isotopic evidence reflects limited inputs from juvenile melts to the high- $\delta^{18}\text{O}$ Paleoarchean and Neoproterozoic granitoids. In the absence of evidence for widespread juvenile magma generation in the zircon Hf record, as would be expected under ‘modern subduction’ conditions, it is more likely that elevated- $\delta^{18}\text{O}$ melts were generated via dehydration melting of supracrustal lithologies. Increased crustal thickening has been modeled as a reasonable way to increase crustal strength and improve the efficiency of sediment burial to melting depth in the Archean (e.g., Payne et al., 2015). Crustal thickening is therefore a consistent mechanism for generating elevated $\delta^{18}\text{O}$ signatures in metamorphic and igneous zircon between 3.6-3.5 Ga (Vezinet et al., 2019, this study) and in igneous zircon at 3.33 and 2.79 Ga (this study). Reworking due to crustal imbrication also reconciles observations from our new zircon oxygen isotope data with existing zircon Hf and whole-rock $^{142}\text{Nd}/^{144}\text{Nd}$ constraints (Wasilewski et al., 2021).

Our observation that igneous SHC zircons record significantly supra-mantle oxygen isotope values during consecutive magmatic events at 3.63, 3.33, and 2.79 Ga demonstrates that at least locally, geodynamic processes enabled burial of low-temperature, hydrously weathered lithologies and development of orogenic-type magmatism early in Earth history. This observation is consistent with previous interpretations that O and Si isotopes in detrital zircons record the development of a hydrosphere and the presence of widespread low-temperature-altered silicious material available for weathering as early as the Hadean (e.g., Valley et al., 2002; Kemp et al., 2010; Trail et al., 2018; Smithies et al., 2021). While the mode of tectonics operating in this part of the Archean was likely quite different from modern subduction, the transfer of high- $\delta^{18}\text{O}$ material to upper or mid-crustal depths at Saglek requires tectonic mixing across crustal levels. Context from zircon Hf isotopes and whole-rock $^{142}\text{Nd}/^{144}\text{Nd}$ suggest that our observation of high- $\delta^{18}\text{O}$ signatures in igneous zircon from several SHC magmatic generations < 3.63 Ga resulted from contemporaneous reworking of long-enduring crustal sources and weathered supracrustal material buried and mixed with limited input from juvenile melts, consistent with crustal thickening in a ‘subcretion’ tectonic regime.

6.0 Conclusions

- Granitic gneisses in the Saglek-Hebron Complex preserve some of the highest igneous zircon $\delta^{18}\text{O}$ values (up to $+8.1 \pm 0.2$ ‰) observed globally in the Archean. The oldest of our high- $\delta^{18}\text{O}$ magmatic zircons at 3.63 Ga temporally precede elevated zircon $\delta^{18}\text{O}$ values previously observed in ~3.5 Ga metamorphic zircons from a Paleoarchean SHC granitoid (Vezinet et al., 2019). Our additional identification of primary geochemistry for high- $\delta^{18}\text{O}$ igneous zircons at 3.33 and 2.79 Ga further indicates the presence of supracrustal material that was altered by aqueous fluids at low temperature (≤ 150 °C) in the SHC during multiple magmatic reworking events spanning the Paleoarchean to the Neoproterozoic.

- Zircon alteration was rigorously assessed through a combined approach involving spatial correlation of zircon oxygen isotope analyses with previously collected U-Pb and Lu-Hf isotopes, pre- and post-analysis imaging, laser Raman, and consideration of geochemical indicators of alteration, such as OH/O and select trace elements. Integrating this multi-screening approach into future zircon oxygen isotope workflows will enable more meaningful comparison of datasets and could help further clarify the mechanisms through which non-mantle-like oxygen isotope ratios were generated in the Archean.
- While Hf isotopes in zircon have been proposed to record widespread onset of mobile-lid tectonics between 3.8 and 3.6 Ga or at 3.2 Ga (e.g., Naerra et al., 2012; Bauer et al., 2020; Drabon et al., 2022), this onset does not necessarily require increased input of high $\delta^{18}\text{O}$ material into magmas (e.g., Drabon et al., 2022). However, the presence of elevated zircon $\delta^{18}\text{O}$ in multiple magmatic generations in the SHC and the correlation of high- $\delta^{18}\text{O}$ with Hf and Nd signatures of crustal reworking not only points towards low-temperature alteration processes active as early as the Hadean-Eoarchean, but also requires repeated local- to regional-scale interaction between a maturing surface environment and magmatic systems from 3.6 Ga onwards. In this context, elevated zircon $\delta^{18}\text{O}$ values in both igneous and metamorphic Archean zircons from select terranes may reflect incorporation of surface-altered lithologies during localized anatectic melting, preceding a broader global shift in subducted sediment composition and volume at the Archean-Proterozoic boundary (e.g., Valley et al., 2005).

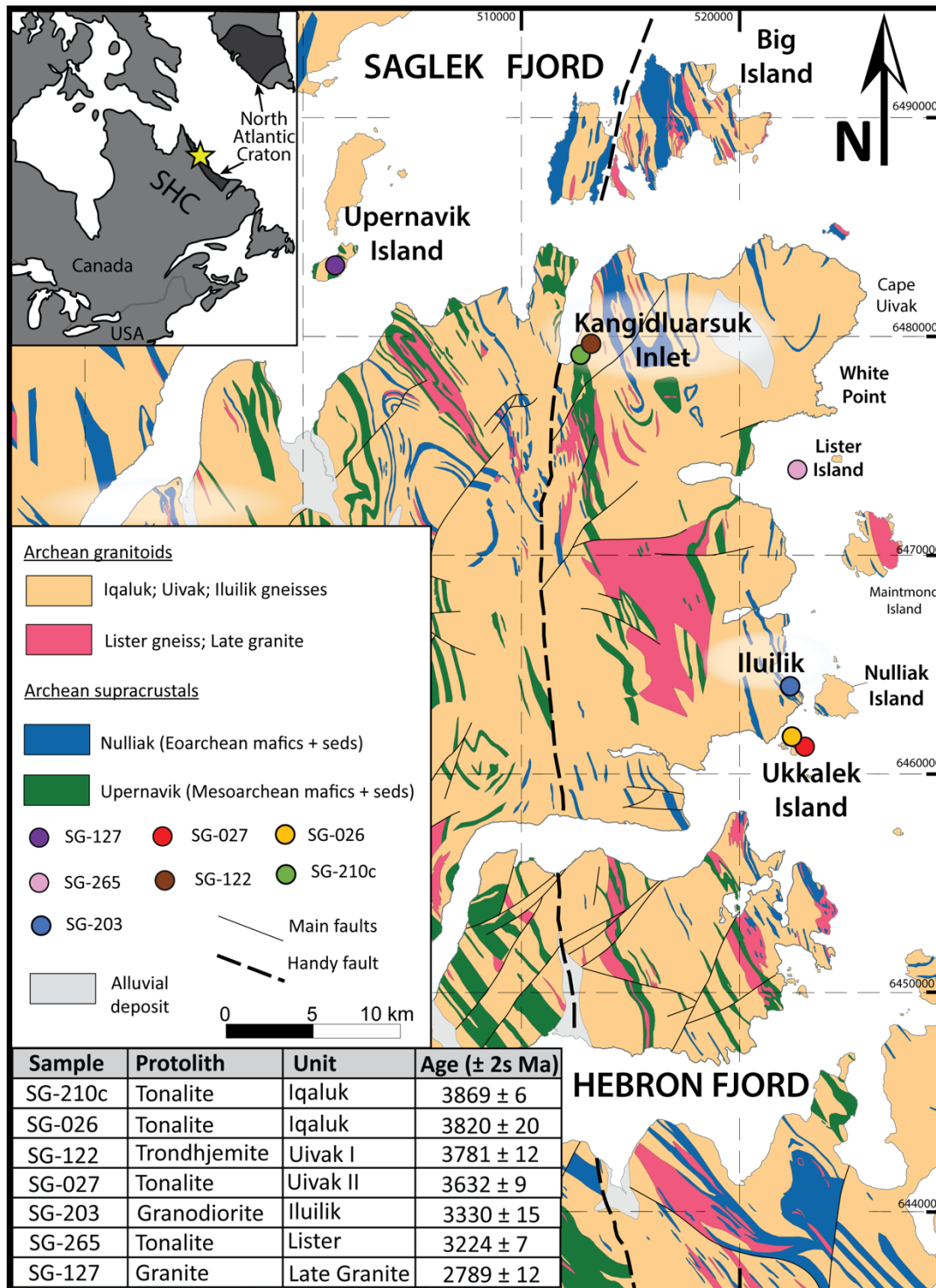


Figure 1: Simplified geologic map of the Saglek-Hebron Complex (SHC) modified from Ryan and Martineau (2012), Komiya et al. (2015) and Wasilewski et al. (2021). All samples are high-grade orthogneisses. Protoliths, units, and ages assigned from Wasilewski et al. (2021). Sample locations (colored circles) have been targeted for zircon oxygen isotopes and trace elements in this study.

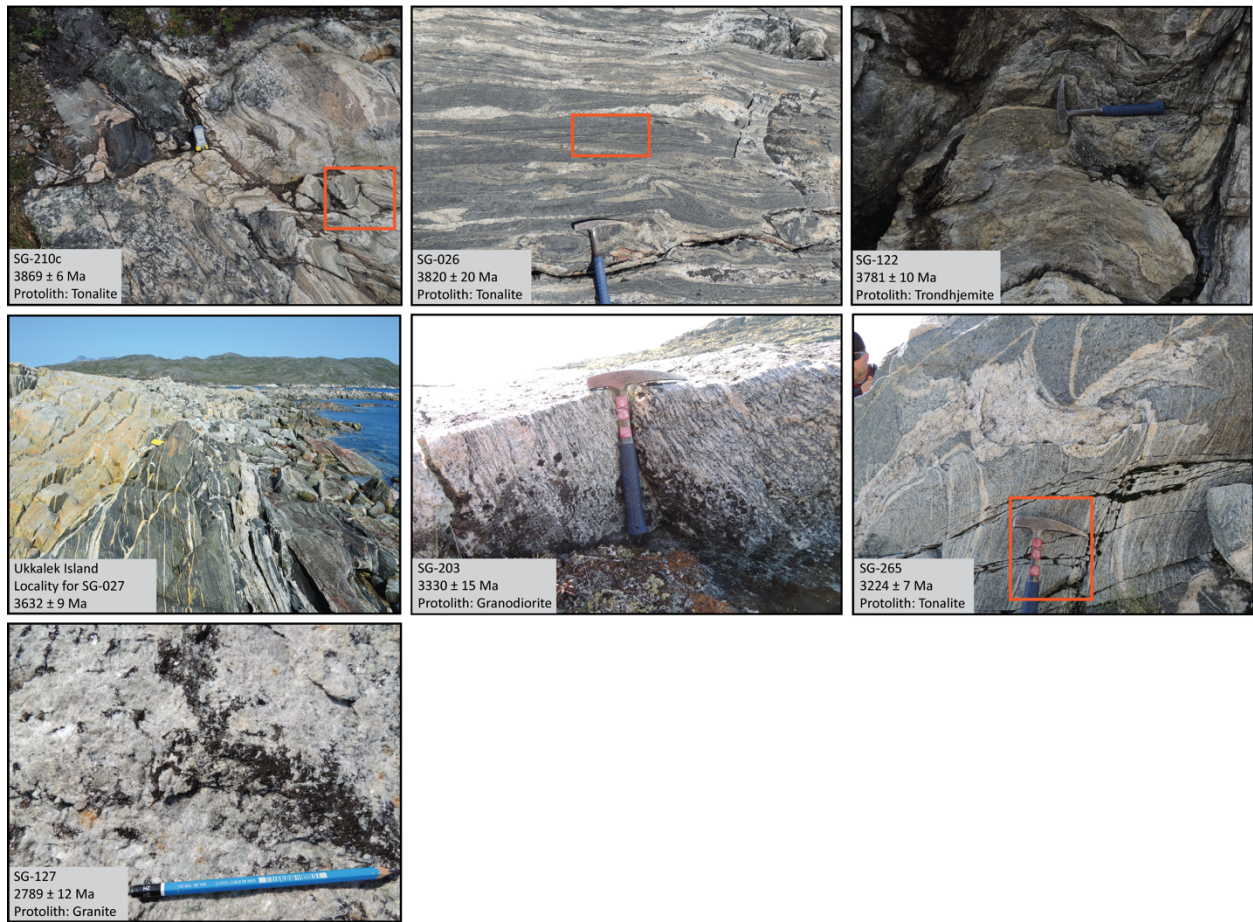


Figure 2: Annotated field photos of sampling locations and representative lithological units for rocks targeted in this study. Where specific sample-scale images are not available, general outcrop scale images are supplied. Ages and protolith determinations are from Wasilewski et al. (2021).

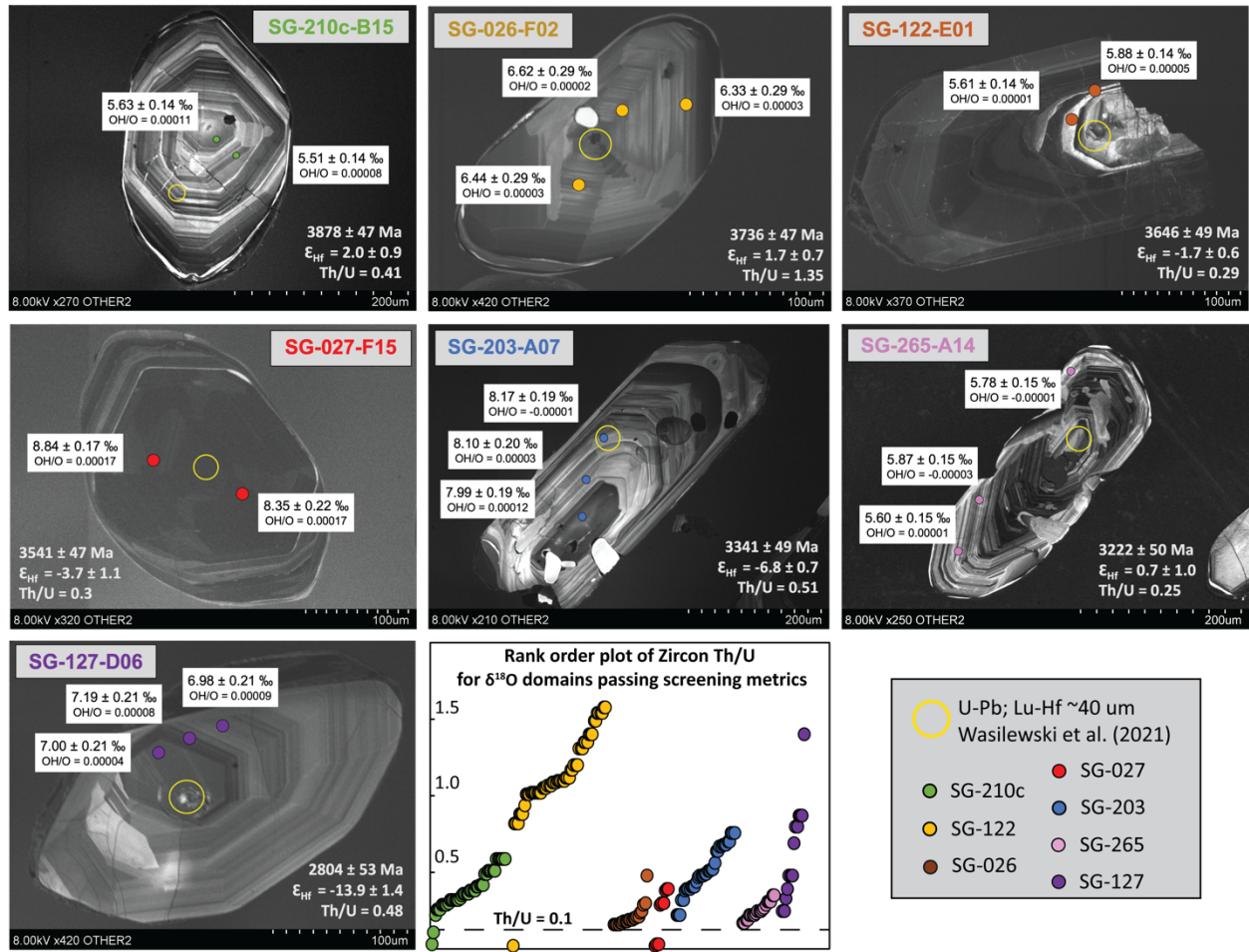


Figure 3: Characteristic zircon CL textures for SHC granitic gneisses from 3.87 to 2.79 Ga, and zircon Th/U for all zircon domains that pass geochemical screening in this study. Images are annotated with $\delta^{18}\text{O}$ and background corrected $^{16}\text{OH}/^{16}\text{O}$ from this study (SIMS oxygen isotope pit, solid-colored circles = $\sim 10 \mu\text{m}$) and U-Pb + Lu-Hf isotope analyses of Wasilewski et al. (2021) (LA-ICPMS spot, open yellow circles = $\sim 40 \mu\text{m}$ for Lu-Hf).

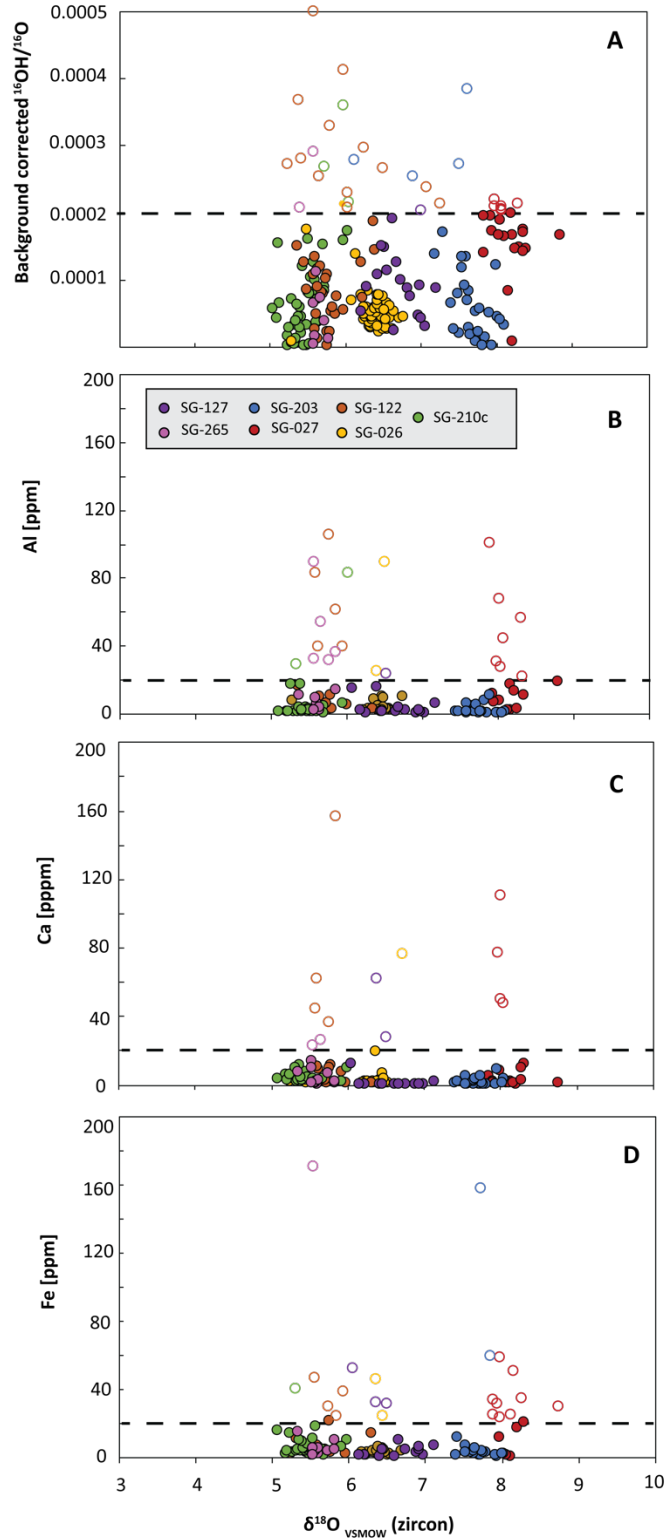


Figure 4: Geochemical screening proxies for zircon alteration ($^{16}\text{OH}/^{16}\text{O}$, Al, Ca, Fe concentration) plotted against zircon $\delta^{18}\text{O}$. This multi-parameter approach to vetting the data indicates retention of primary oxygen isotope geochemistry for 77% of our zircon $\delta^{18}\text{O}$ analyses. Zircon domains are considered geochemically altered (open circles) if one or more of the following is met: $^{16}\text{OH}/^{16}\text{O} > 0.0002$; Al, Ca, Fe > 20 ppm. No significant correlations are observed between our screening parameters and zircon $\delta^{18}\text{O}$.

Table 1. Zircon $\delta^{18}\text{O}$ data for the Saglek-Hebron granitoids

Sample	Location	Magmatic Event	Protolith	Crystallization Age $\pm 2\sigma$ (Ma)	Mean zircon $\epsilon\text{Hf}_{(t)} \pm 2\sigma$	Whole-Rock $\mu^{142}\text{Nd} \pm 2\sigma$	Zircon $\delta^{18}\text{O}$ (max, min)	<i>n</i> / <i>total</i>	Weighted Mean zircon* $\delta^{18}\text{O} \pm 2\text{ SE}$	Mean zircon $^{16}\text{OH}/^{16}\text{O}$
SG-210c	Kangidluarsuk Inlet	Iqaluk	Tonalite	3869 $\pm$ 6	1.8 $\pm$ 0.2	14.9 $\pm$ 3.8	(5.97, 5.03)	45/50	5.47 $\pm$ 0.03	5.3E-05
SG-026	Ukkalek Island	Iqaluk	Tonalite	3829 $\pm$ 20	3.7 $\pm$ 0.2	8.1 $\pm$ 4.1	(6.71, 5.28)	57/62	6.42 $\pm$ 0.02	5.2E-05
SG-122	Kangidluarsuk Inlet	Uivak I	Trondhjemite	3781 $\pm$ 12	1.7 $\pm$ 0.2	7.4 $\pm$ 3.7	(6.23, 5.36)	18/37	5.69 $\pm$ 0.09	7.9E-05
	<i>SG-122 younger metamorphic rims</i>			2804 $\pm$ 9	- -	- -	(6.39, 6.21)	3/4	6.32 $\pm$ 0.08	1.5E-04
SG-027	Ukkalek Island	Uivak II	Tonalite	3632 $\pm$ 9	-1.1 $\pm$ 0.3	8.8 $\pm$ 2.8	(8.36, 7.91)	9/21	8.12 $\pm$ 0.06	1.4E-04
	<i>SG-027 younger metamorphic rims</i>			2785 $\pm$ 7	- -	- -	(8.29, 7.82)	3/3	8.13 $\pm$ 0.15	1.6E-04
SG-203	Opposite coast of Nulliak	Ilulik	Granodiorite	3330 $\pm$ 15	-6.3 $\pm$ 0.2	5.9 $\pm$ 2.8	(8.17, 7.18)	40/47	7.77 $\pm$ 0.04	3.7E-05
SG-265	Lister Island	Lister	Tonalite	3224 $\pm$ 7	1 $\pm$ 0.3	2.3 $\pm$ 4	(5.87, 5.54)	20/27	5.68 $\pm$ 0.03	4.7E-06
SG-127	Upernavik Island	Late Granite	Granite	2789 $\pm$ 12	-12 $\pm$ 0.2	10.1 $\pm$ 4	(7.16, 6.20)	16/20	6.73 $\pm$ 0.15	8.4E-05

Magmatic events, lithologies, ages, and $\epsilon\text{Hf}(t)$ assigned by Wasilewski et al. (2021). Sample locations shown in Figure 1.

$\mu^{142}\text{Nd}$ values from Wasilewski et al. (2022)

n = number of analyses that pass geochemical screening criteria. Screening metrics can be found in Table S1. Raw oxygen isotope data in Tables S3 and S4

* Weighted mean of all oxygen isotope analyses from a given sample.

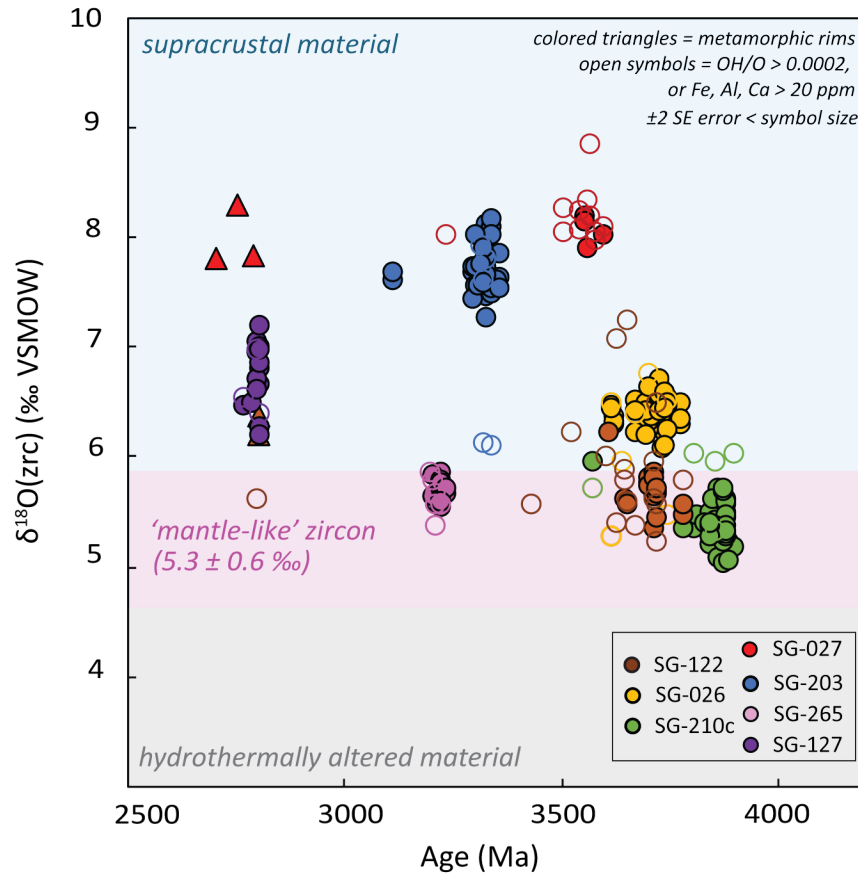


Figure 5: Individual oxygen isotope analyses (this study) plotted at the zircon domain ages of Wasilewski et al. (2021). Open colored symbols denote data points where $^{16}\text{OH}/^{16}\text{O} > 0.0002$ or Ca-Al-Fe screening criteria are not met, and colored triangles symbolize younger metamorphic rims, as identified by U-Pb data. Crystallization ages for each rock can be found in **Table 1** and **Figure 8**.

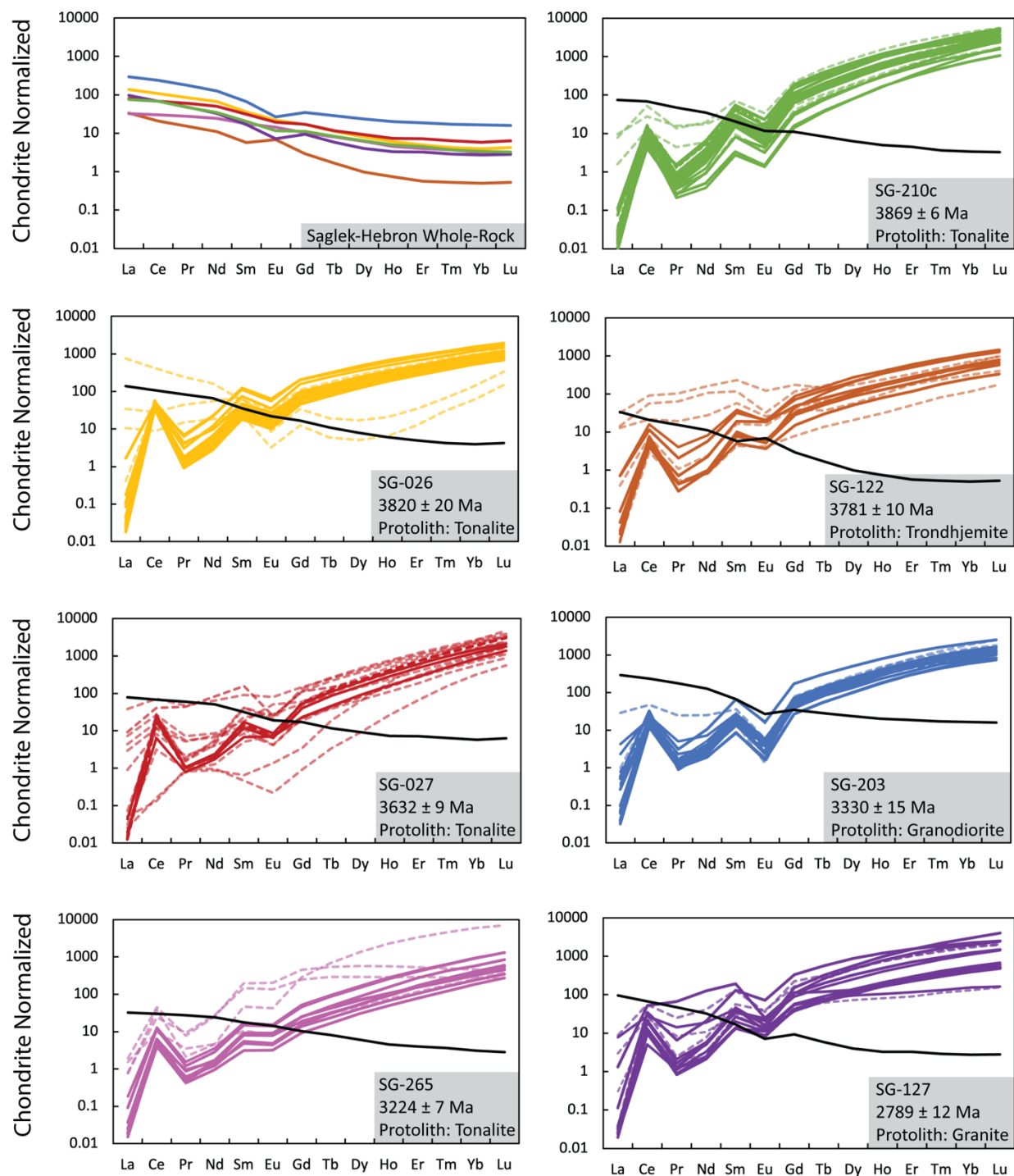


Figure 6: Measured REE concentrations from this study for seven SHC granitic gneisses and their zircons, normalized to chondrite compositions using values from McDonough and Sun (1995). The black line is the measured whole-rock REE concentrations for each granitoid (Wasilewski et al., 2021). Dashed colored lines are zircon data that did not pass Ca, Al, Fe, OH/O screening metrics (see **Section 3.3** for details).

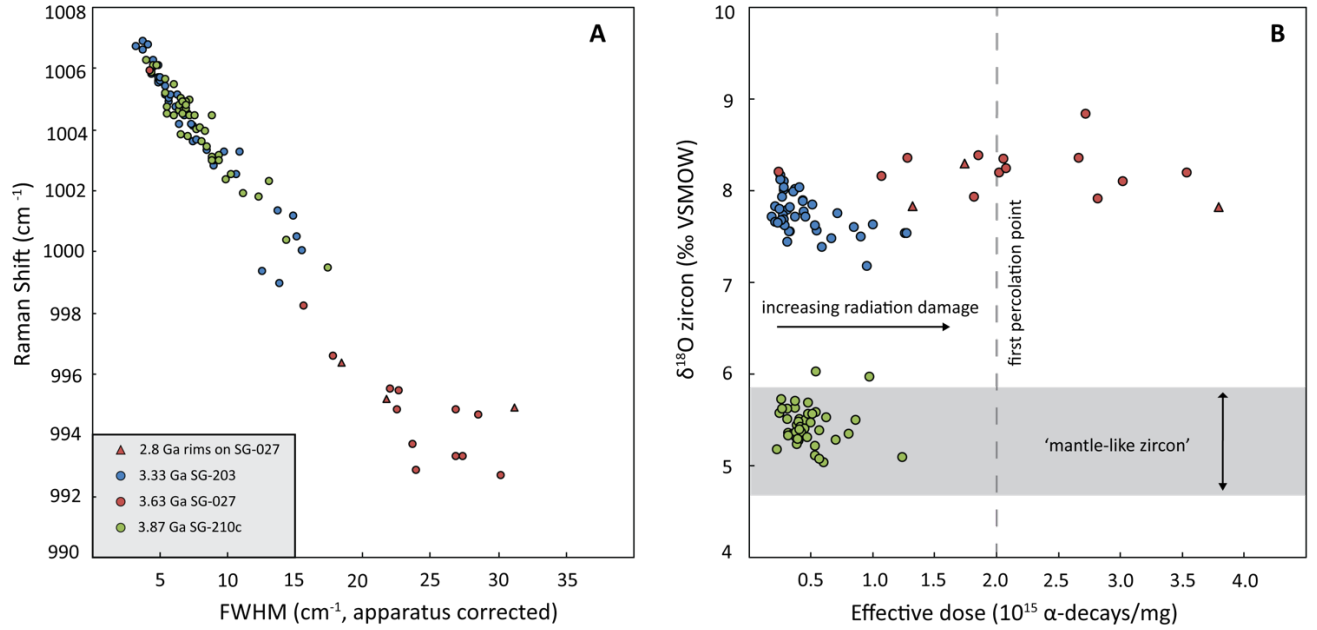


Figure 7: (A) $\nu_3(\text{SiO}_4)$ peak width (FWHM) vs Raman shift (cm^{-1}) for all zircon domains targeted by oxygen isotope analysis for 3.87 Ga tonalite SG-210c, 3.63 tonalite SG-027, and 3.33 granodiorite SG-203 ($n = 2$ or 3 Raman spectra per $\delta^{18}\text{O}$ spot). (B) Zircon $\delta^{18}\text{O}$ vs effective dose ($10^{15} \alpha\text{-decays/mg}$) for each domain shown in panel A.

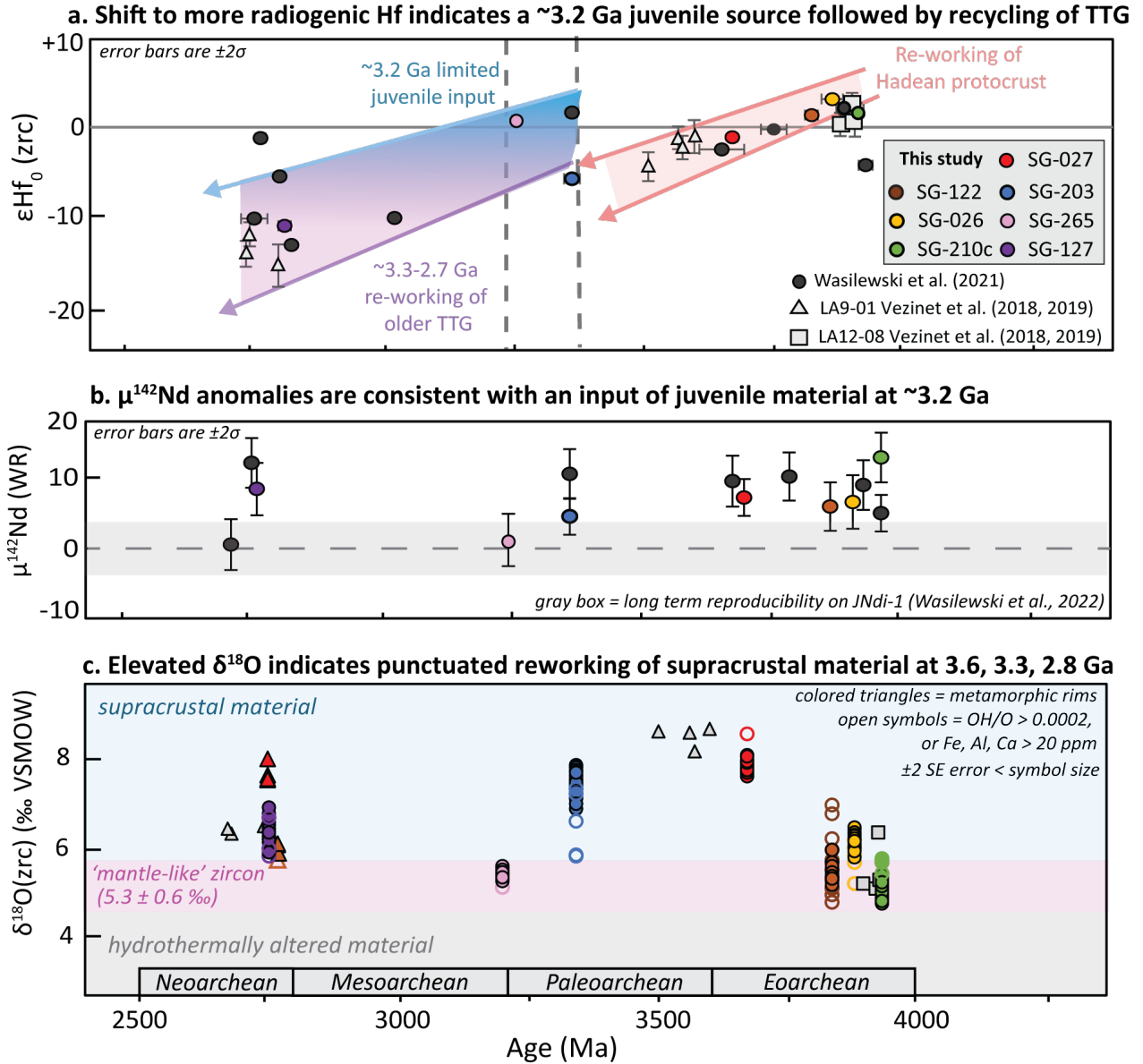


Figure 8: Integrated isotopic data for the SHC illustrating that crustal reworking in the Archean involved geochemical mixing across multiple crustal levels (e.g., long-enduring crustal sources are actively mixed with supracrustal material). **(A)** Zircon εHf_0 data for SHC granitoids from Wasilewski et al. (2021) and Vezinet et al. (2018; 2019). Colored dots denote the samples from Wasilewski et al. (2021) that were targeted for oxygen isotope work in this study. **(B)** Whole-rock ^{142}Nd data from Wasilewski et al. (2022). Symbols for SHC are the same as in panel A. **(C)** Individual oxygen isotope analyses (this study) stacked at the assigned ages of Wasilewski et al. (2021). Open colored symbols denote data points where $^{16}\text{OH}/^{16}\text{O} > 0.0002$ or Ca-Al-Fe screening criteria are not met, and colored triangles symbolize younger metamorphic rims, as identified by U-Pb data. Previously published zircon oxygen analyses for zircons from SHC metaigneous rocks from Vezinet et al. (2018; 2019) are shown for context using symbols from panel A.

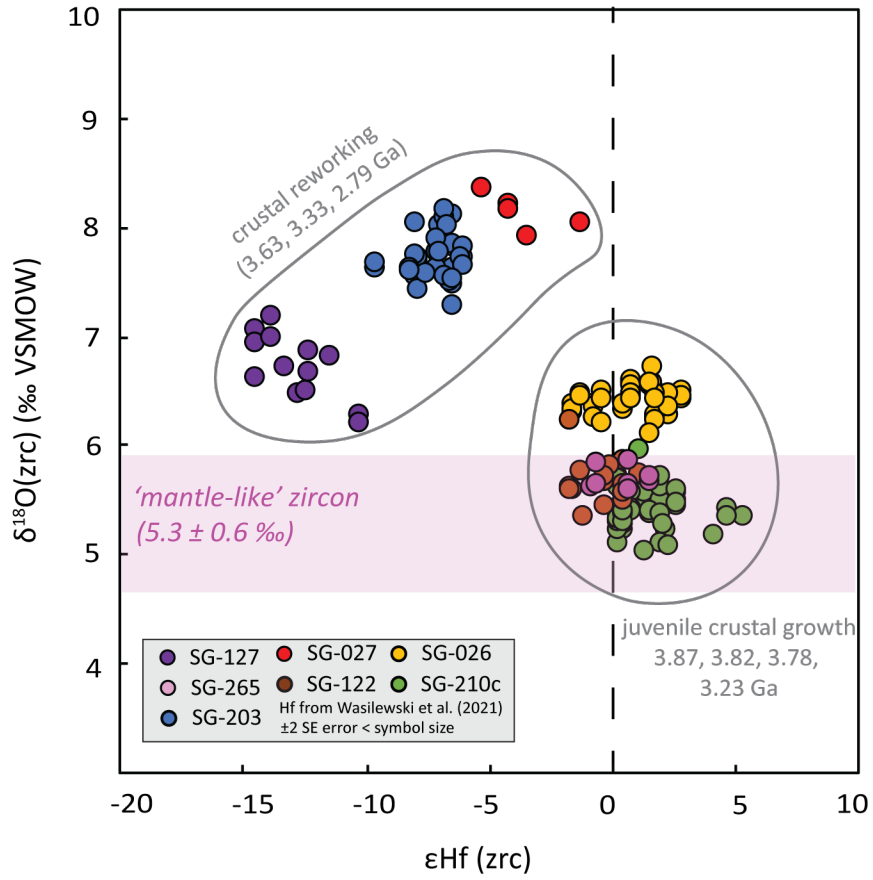


Figure 9: In the SHC, juvenile crustal growth events are characterized by mantle-like zircon $\delta^{18}\text{O}$, while isolated reworking events correlate with elevated zircon $\delta^{18}\text{O}$. Only oxygen isotope data from zircon cores that meet screening criteria (see **Section 3.3** for details) are displayed.

Supplemental Figures

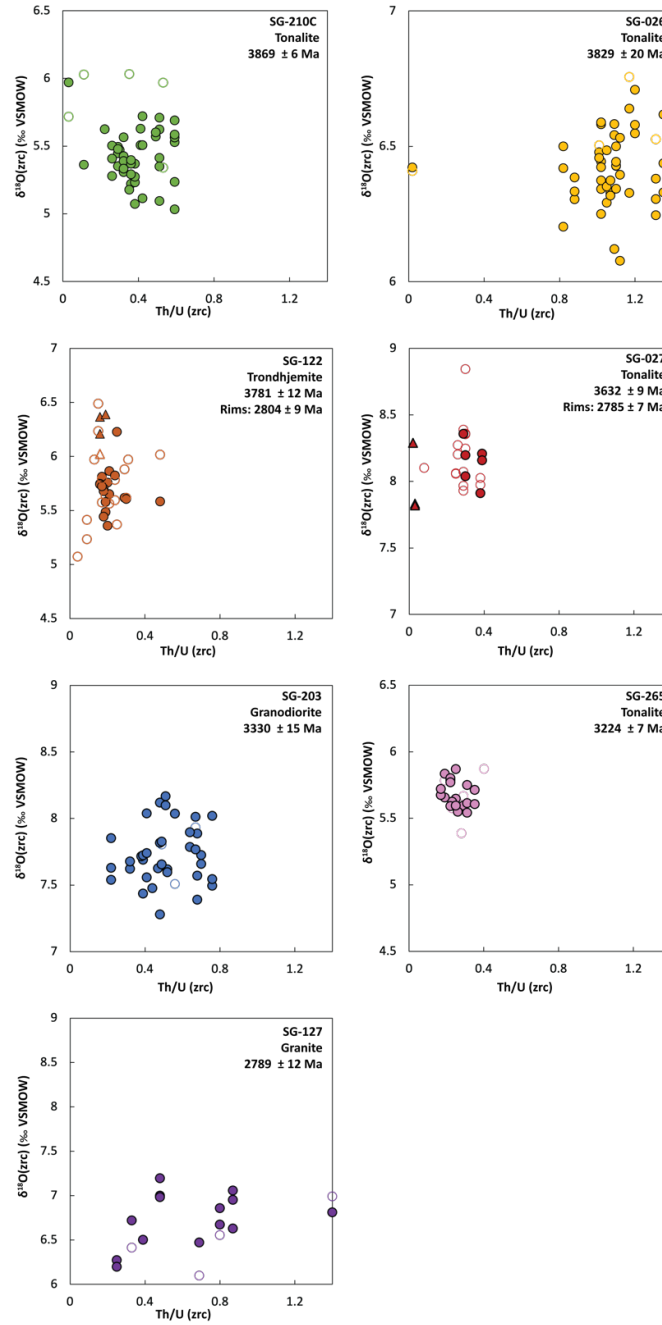


Figure S1: Zircon Th/U (from Wasilewski et al., 2021) vs zircon $\delta^{18}\text{O}$ for each granitoid targeted in this study. Open colored symbols denote data points where $^{16}\text{OH}/^{16}\text{O} > 0.0002$ or Ca-Al-Fe screening criteria are not met, and colored triangles symbolize younger metamorphic rims, as identified by U-Pb data.

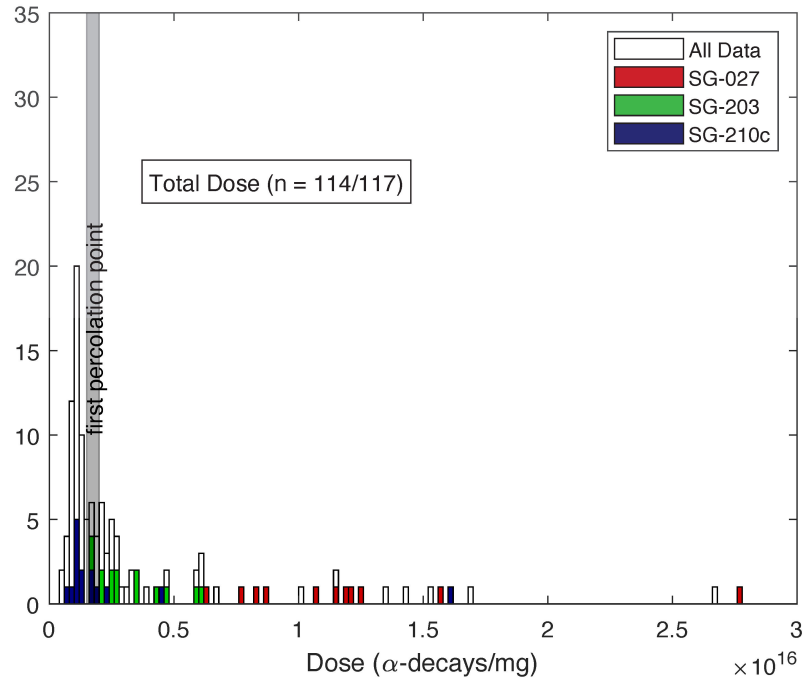


Figure S2: Calculated total alpha dose values ($10^{16} \alpha$ -decays/mg) for all SHC zircons targeted in this study. These values assume no annealing. Samples for which Raman data have been measured are colored. The measured doses are lower than calculated values that are shown here.

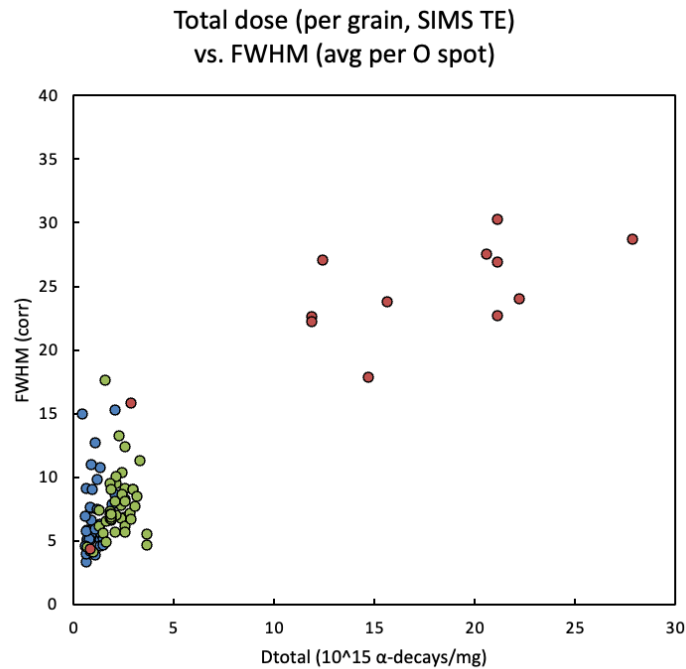


Figure S3: Calculated total alpha dose values ($10^{15} \alpha$ -decays/mg) for all SHC zircons targeted in this study shown relative to $\nu_3(\text{SiO}_4)$ peak width (FWHM) for all zircon domains targeted by oxygen isotope analysis for 3.87 Ga tonalite SG-210c, 3.63 tonalite SG-027, and 3.33 granodiorite SG-203.

Supplemental Tables (excel file)

- **Table S1:** Correlated O and TE data (this study) with U-Pb and Hf data (Wasilewski et al., 2021)
- **Table S2:** Raman data and alpha dose calculations for SG-027, SG-203, SG-265
- **Table S3:** WiscSIMS $\delta^{18}\text{O}$ Summary for Session 1 (06-2022)
- **Table S4:** WiscSIMS $\delta^{18}\text{O}$ Summary for Session 2 (11-2022)
- **Table S5:** WiscSIMS TE Summary for all samples (08-2022)

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Author contributions: E.E.M and T.B.B. conducted zircon oxygen isotope measurements, zircon TE measurements, and Raman analysis. E.E.M. additionally carried out CL/BSE imaging, data analysis, and initial drafting of the manuscript with supervision from A.M.B. Samples were initially collected and characterized by J.O., H.R., and their graduate students. All authors contributed to conceptual development of the project, data interpretation, and revision/editing of the manuscript.

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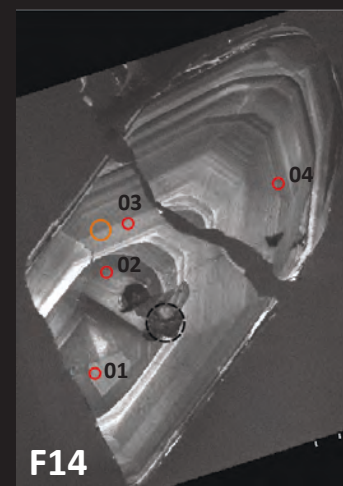
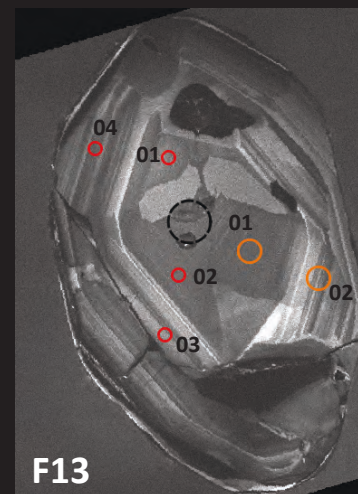
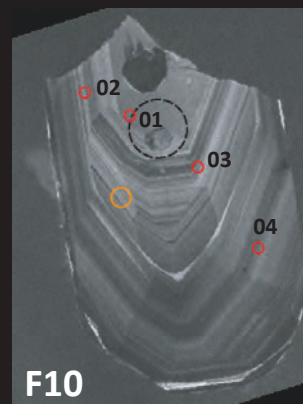
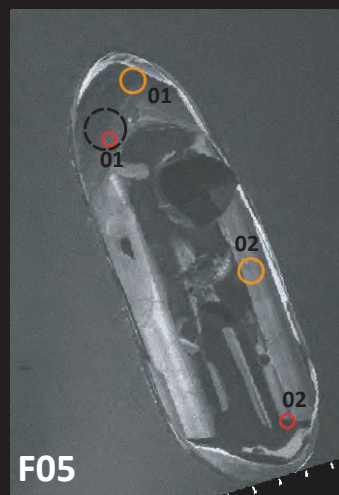
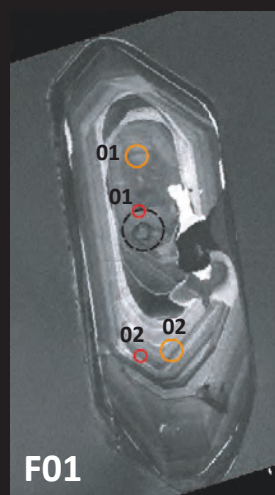
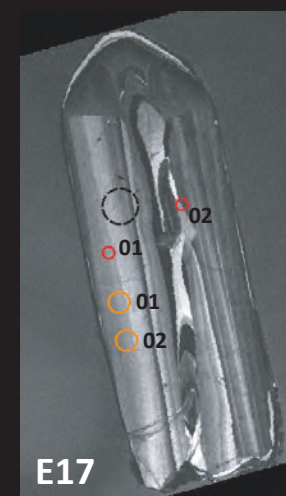
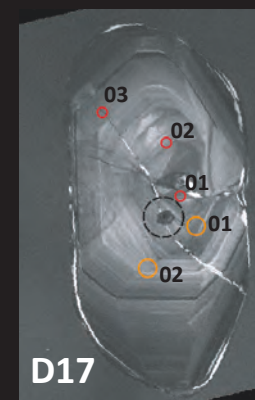
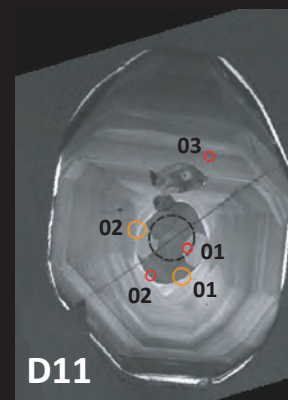
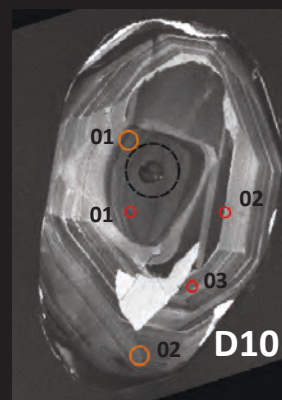
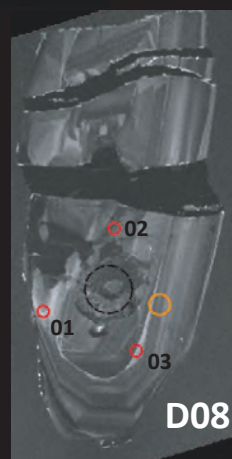
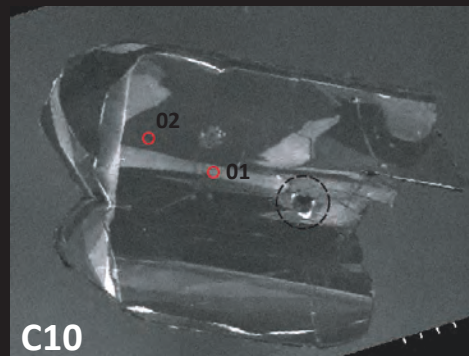
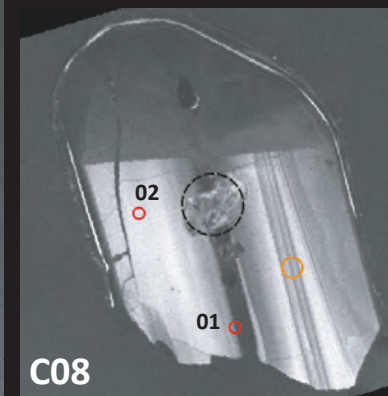
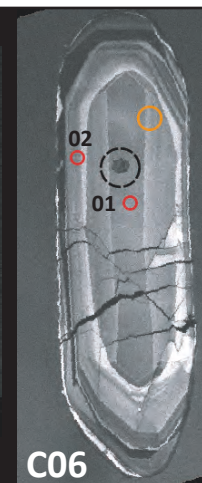
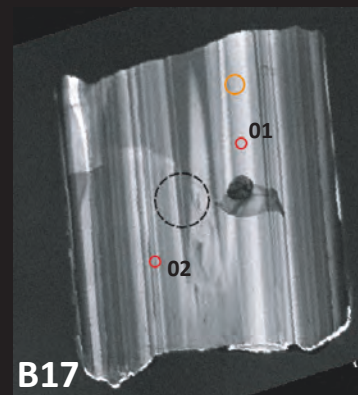
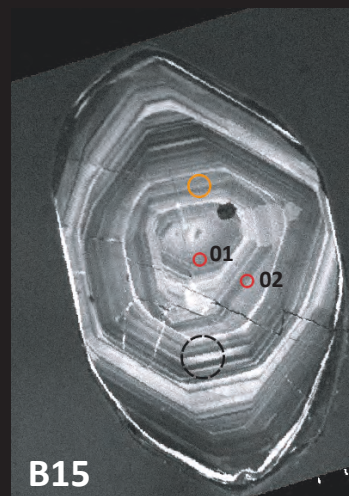
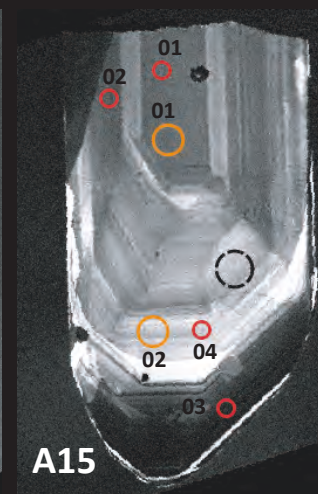
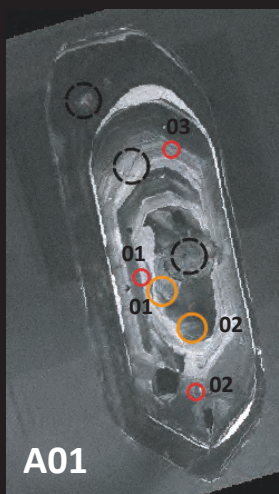
SG-210c

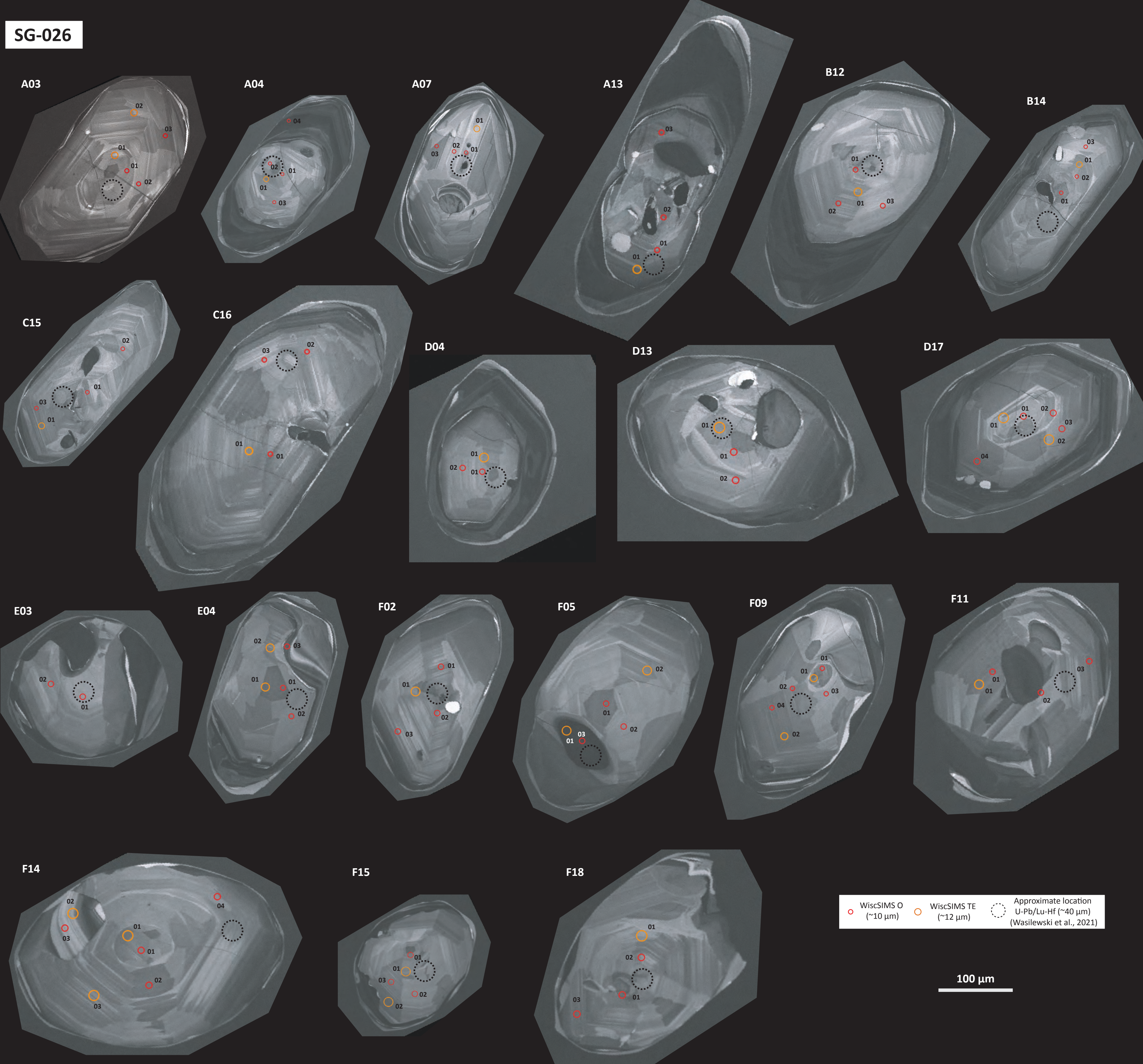
100 μm

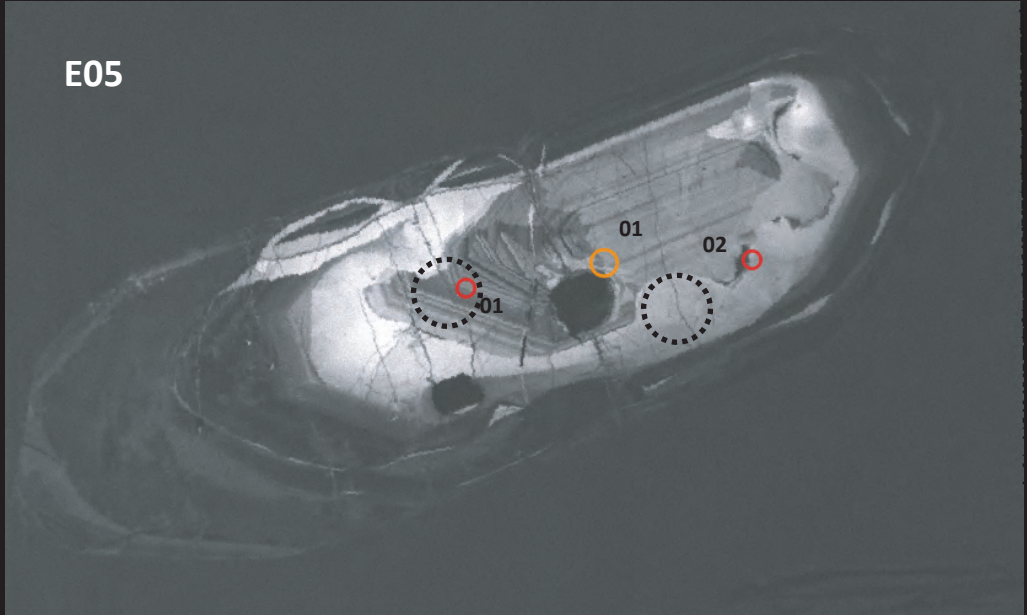
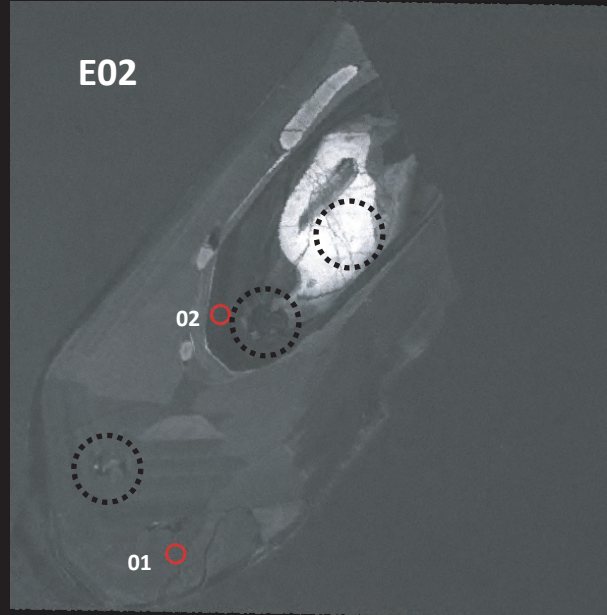
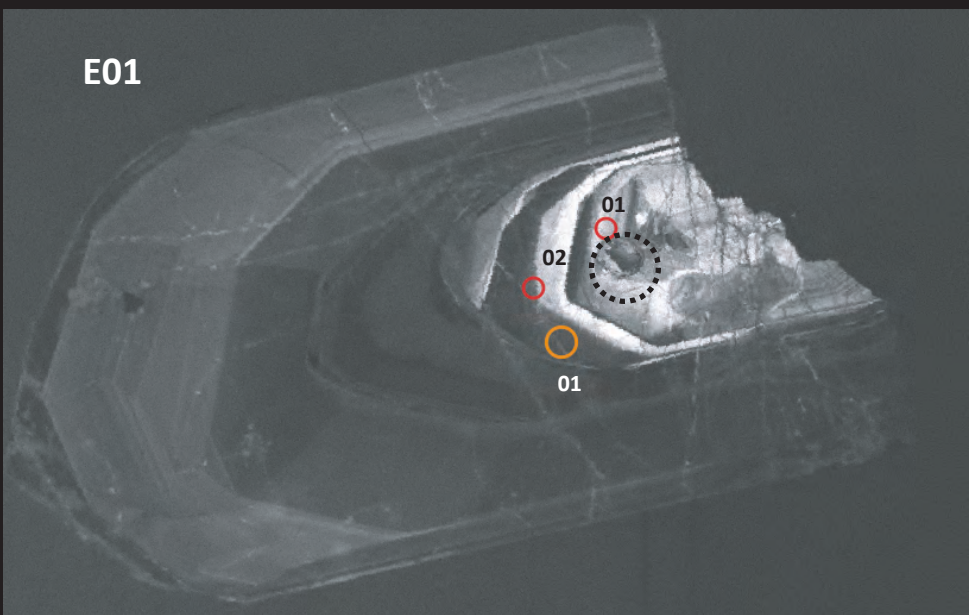
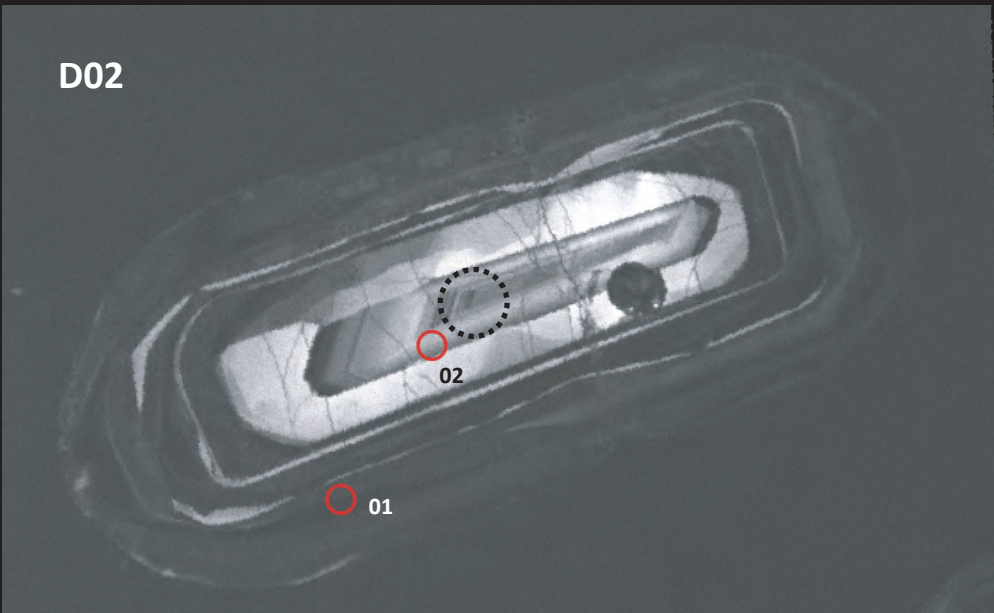
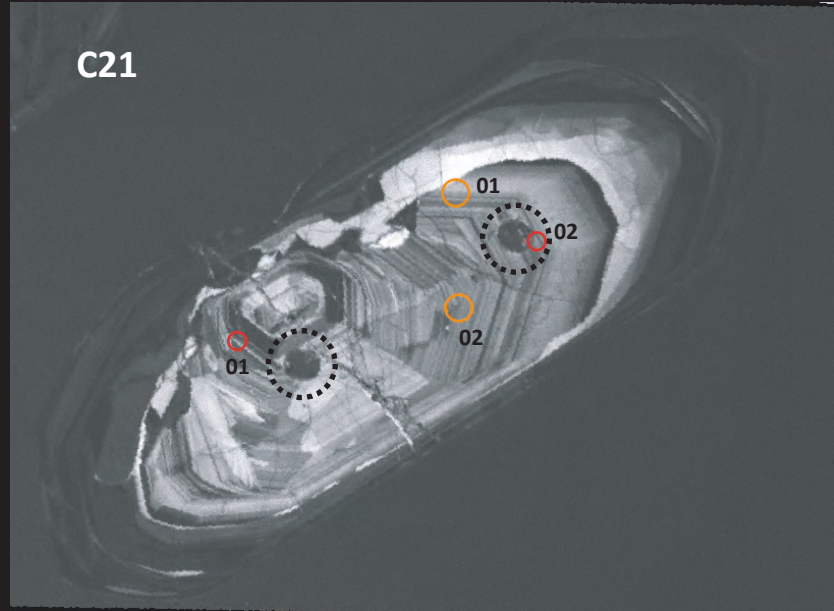
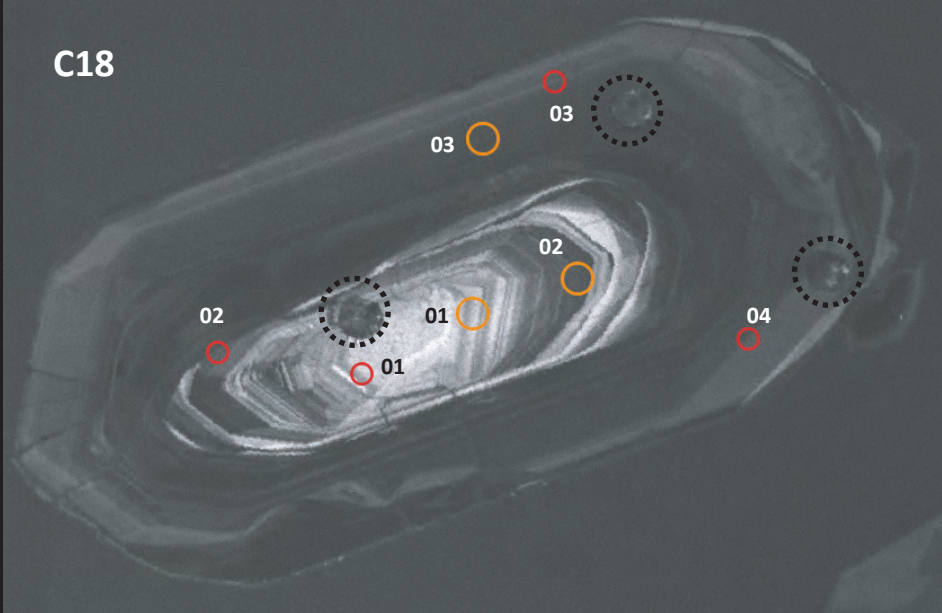
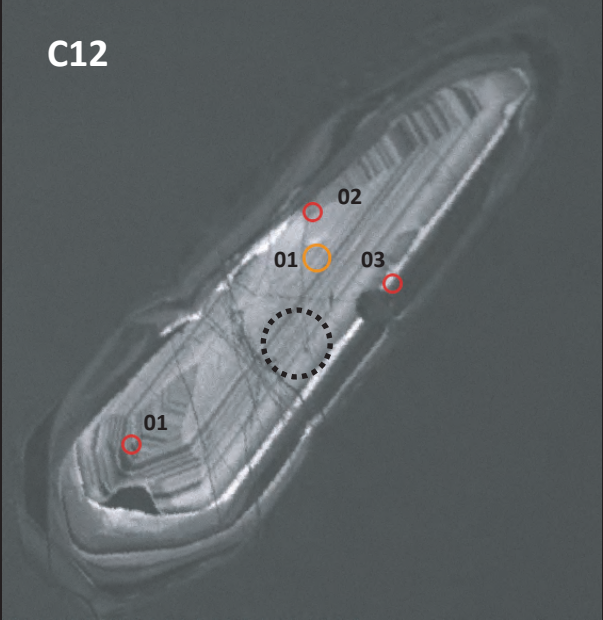
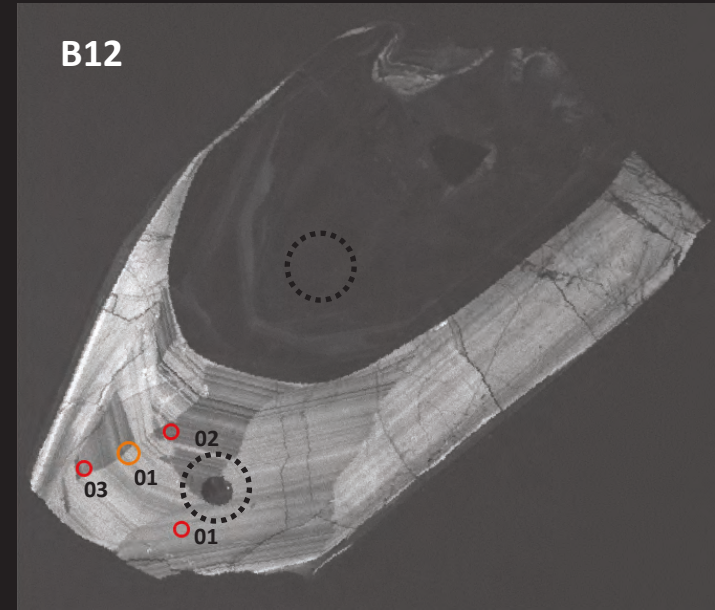
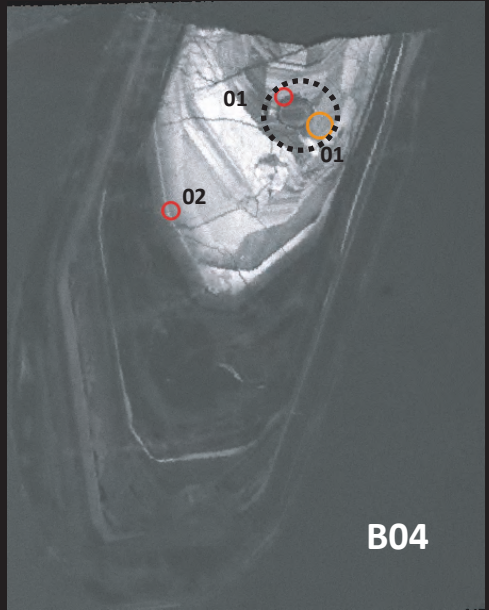
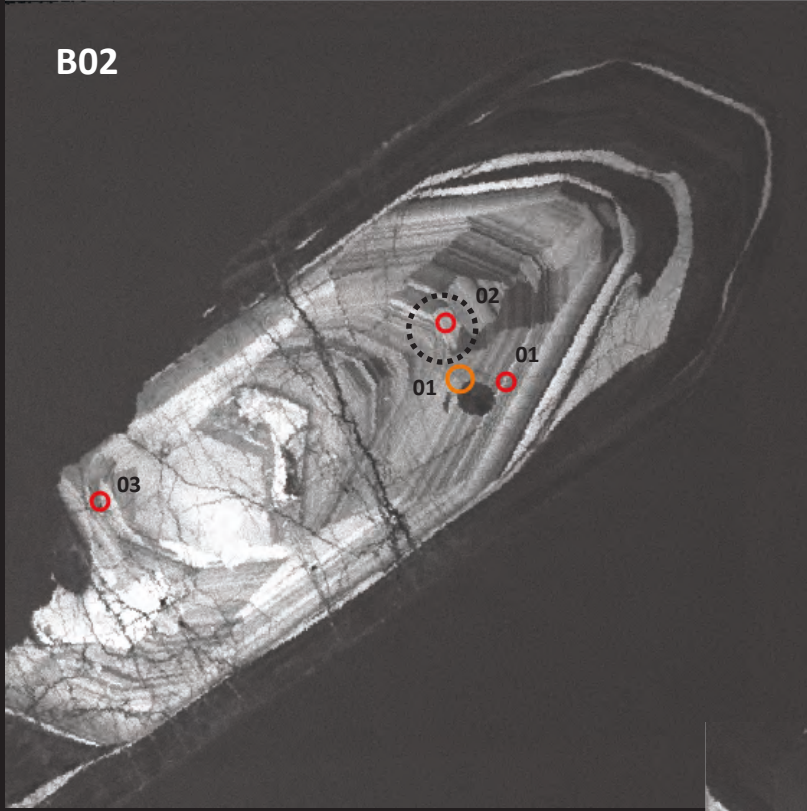
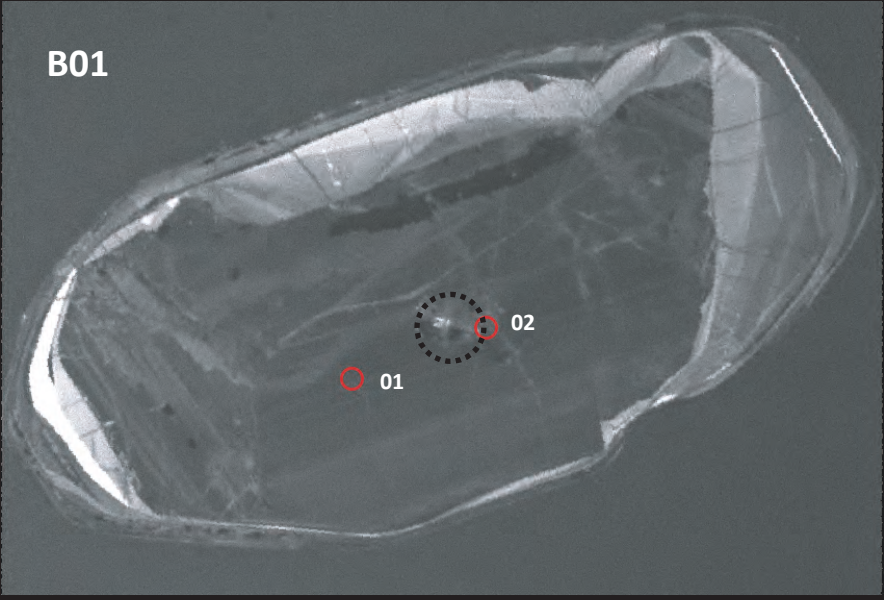
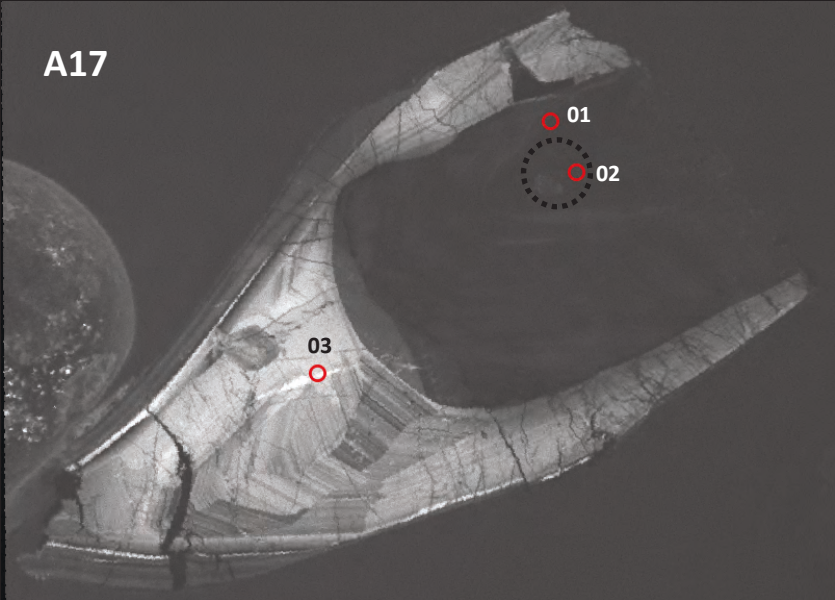
WiscSIMS O
($\sim 10\ \mu\text{m}$)

WiscSIMS TE
($\sim 12\ \mu\text{m}$)

Approximate location
U-Pb/Lu-Hf ($\sim 40\ \mu\text{m}$)
(Wasilewski et al., 2021)







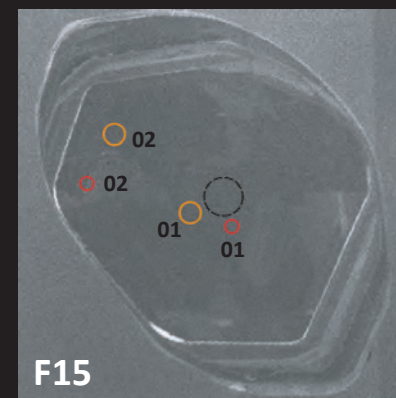
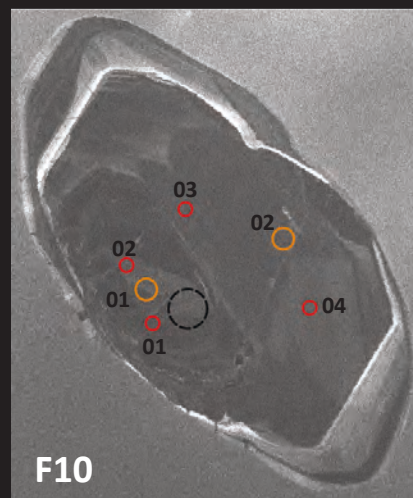
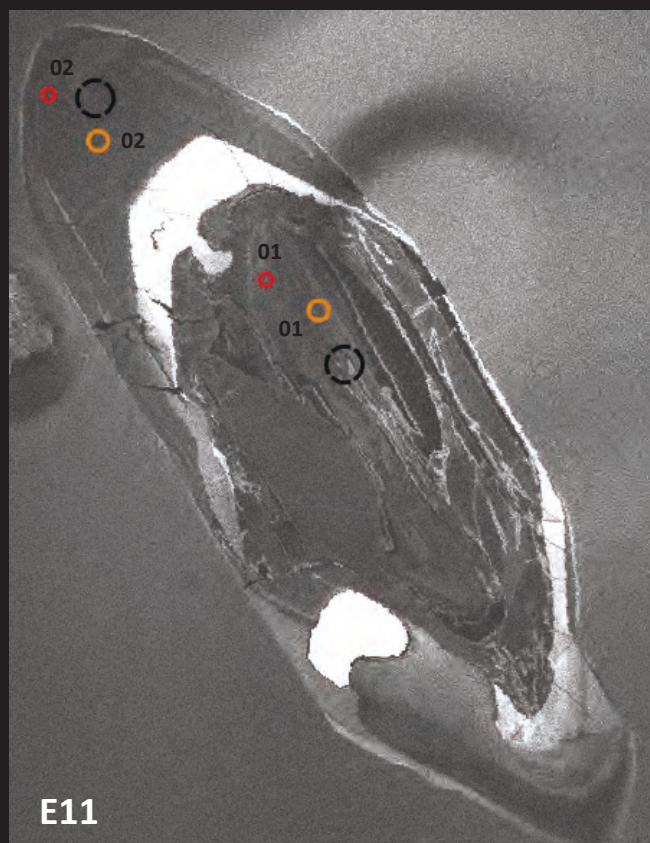
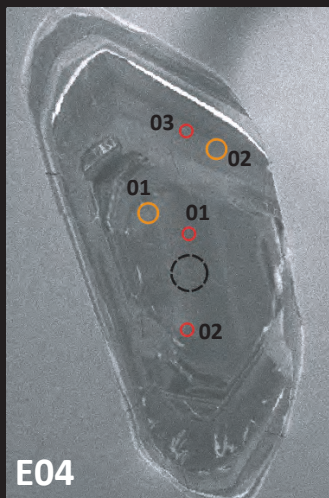
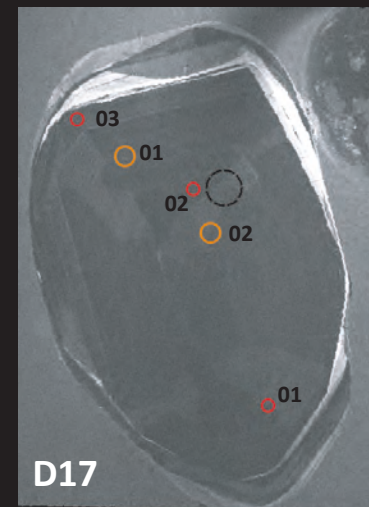
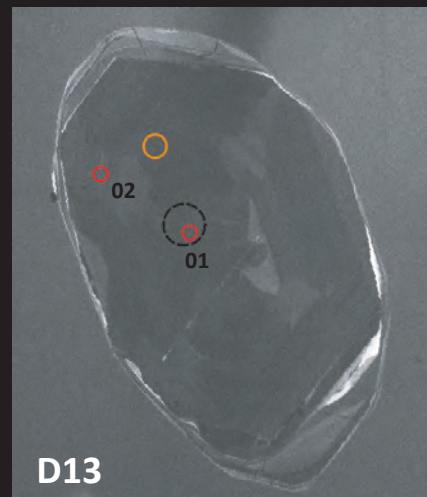
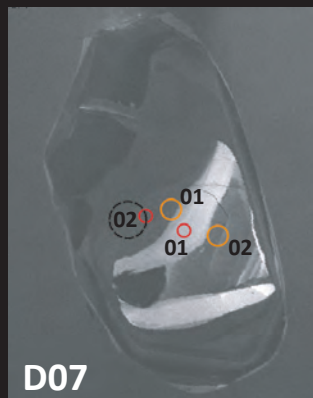
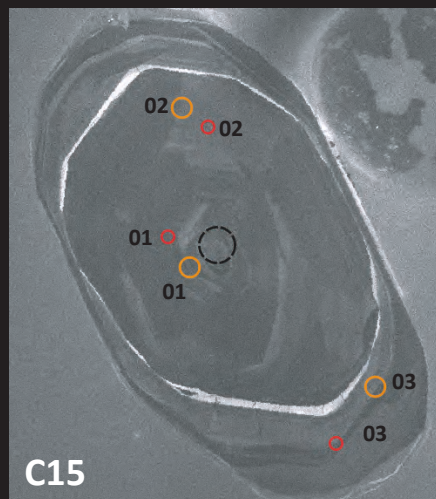
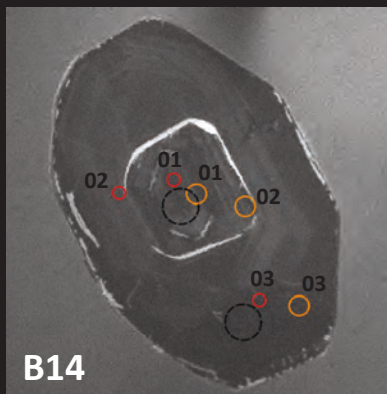
SG-027

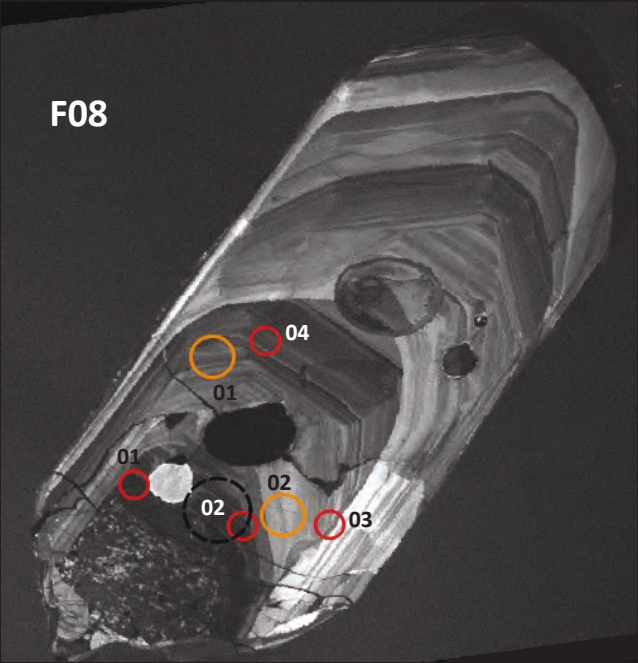
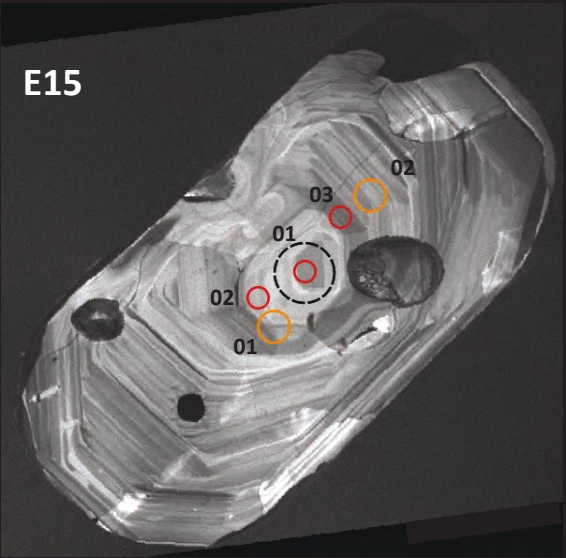
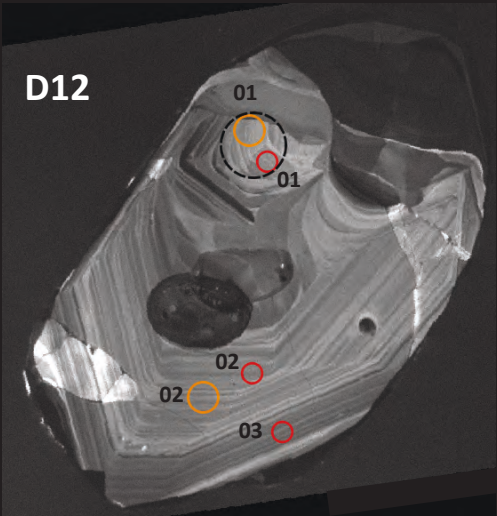
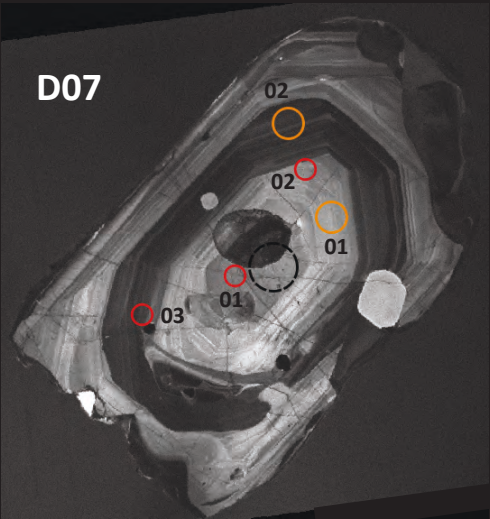
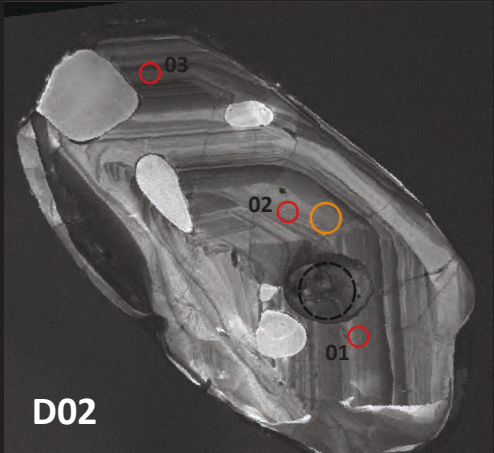
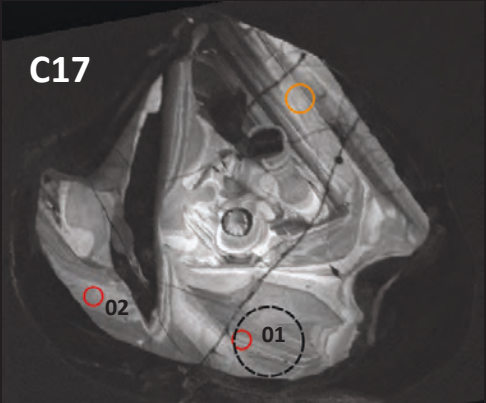
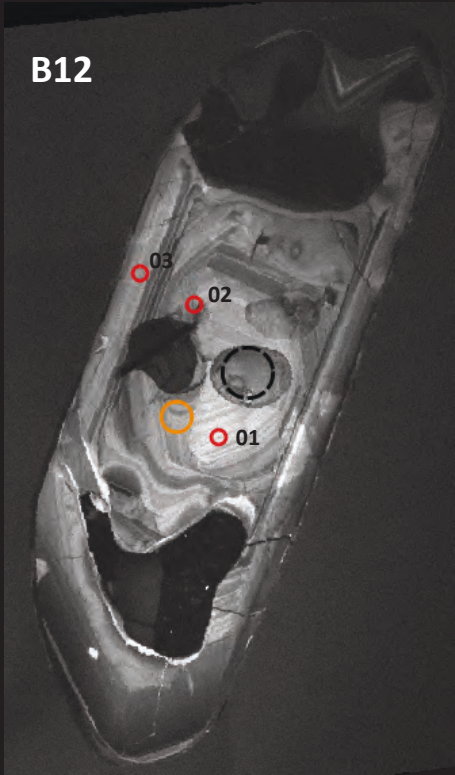
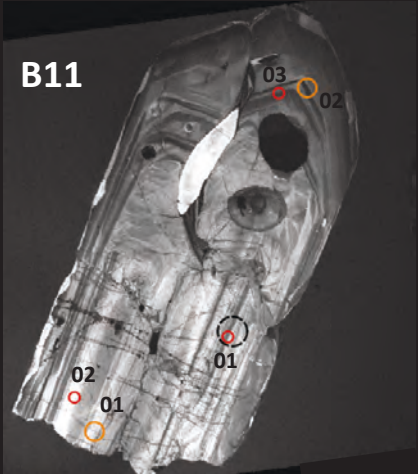
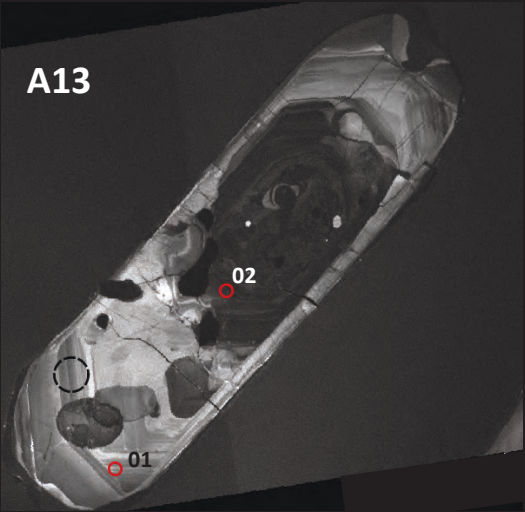
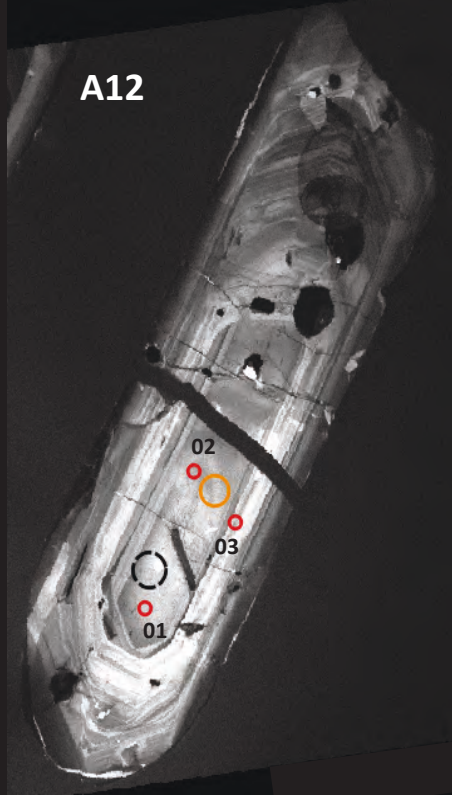
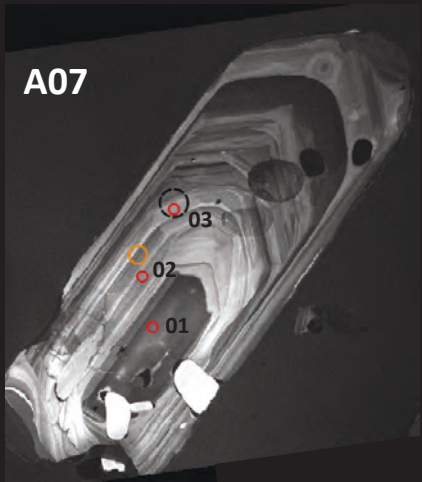
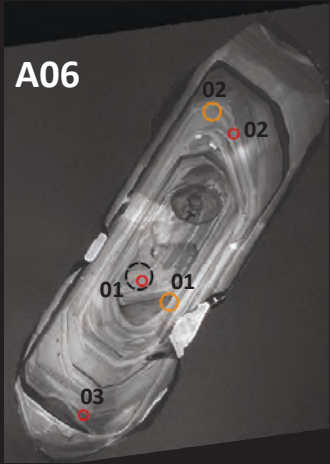
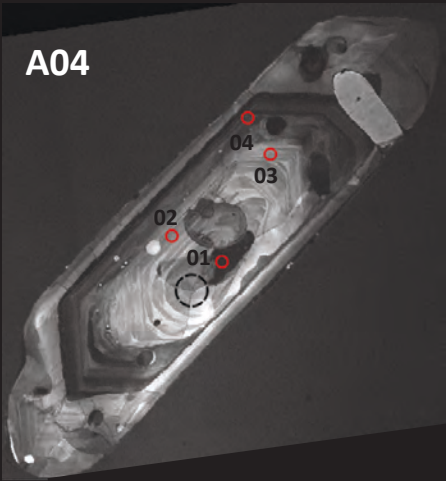
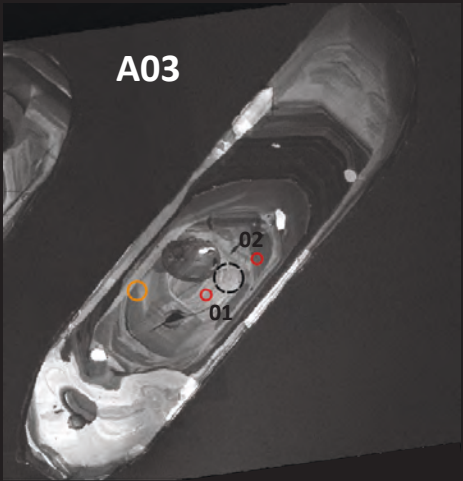
100 μm

WiscSIMS O
($\sim 10\ \mu\text{m}$)

WiscSIMS TE
($\sim 12\ \mu\text{m}$)

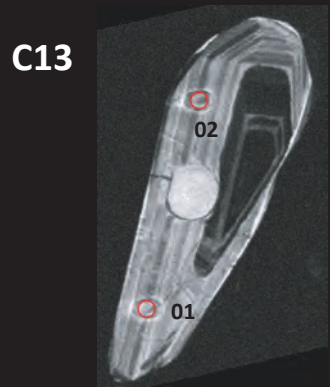
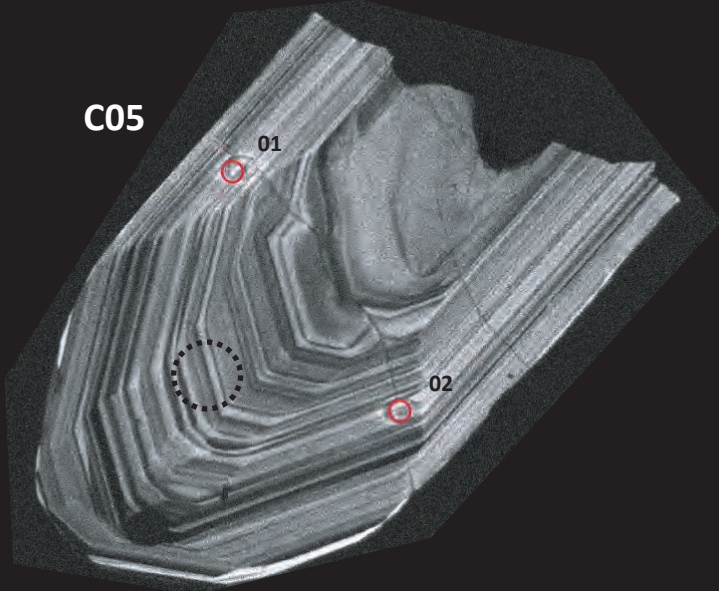
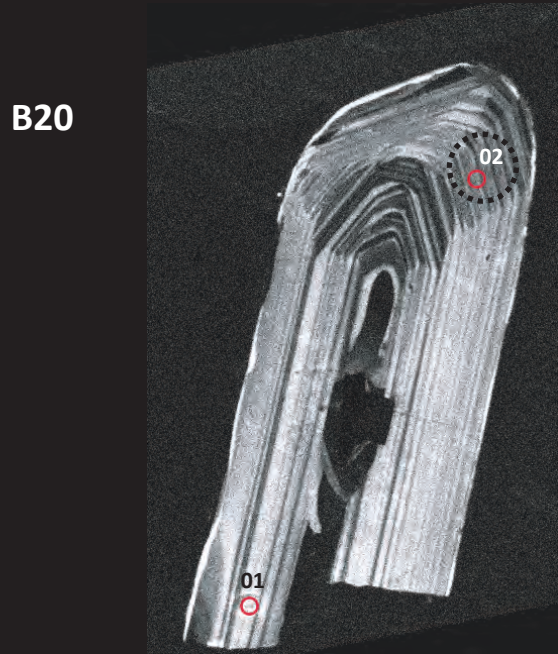
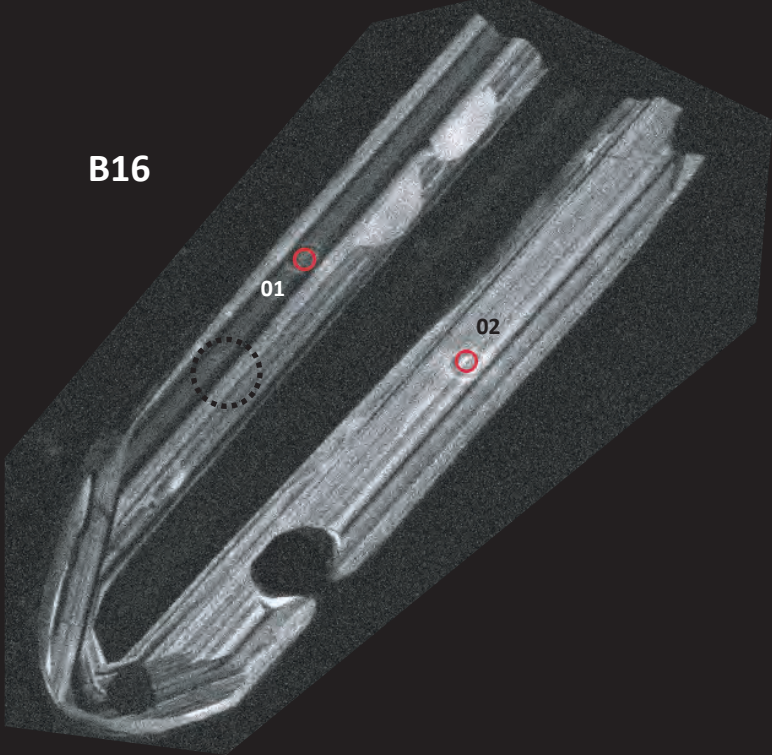
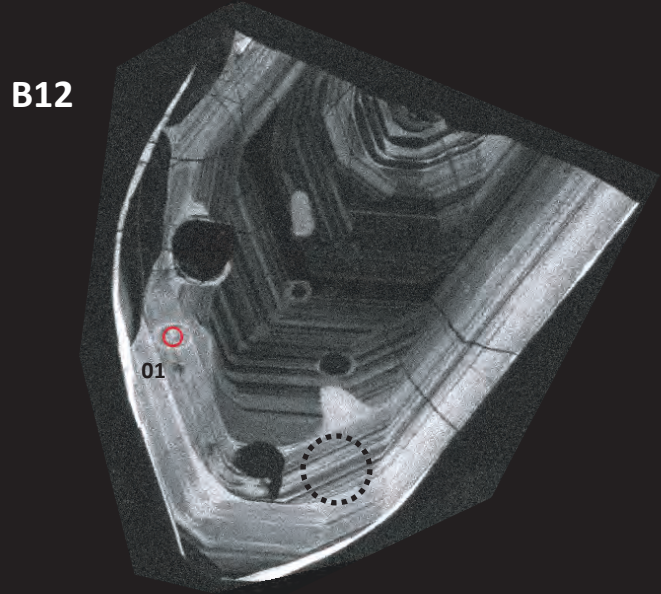
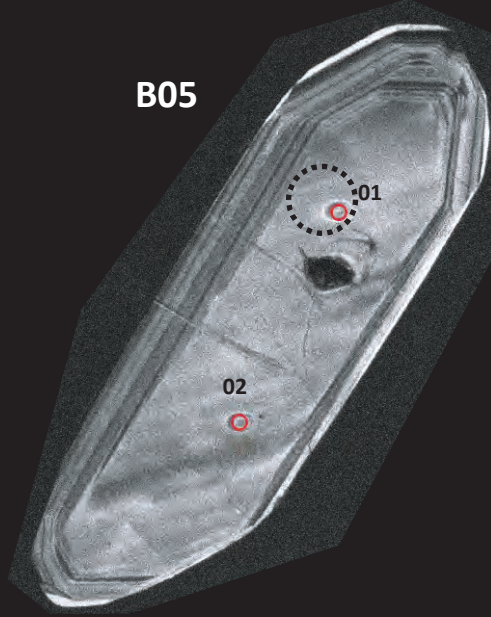
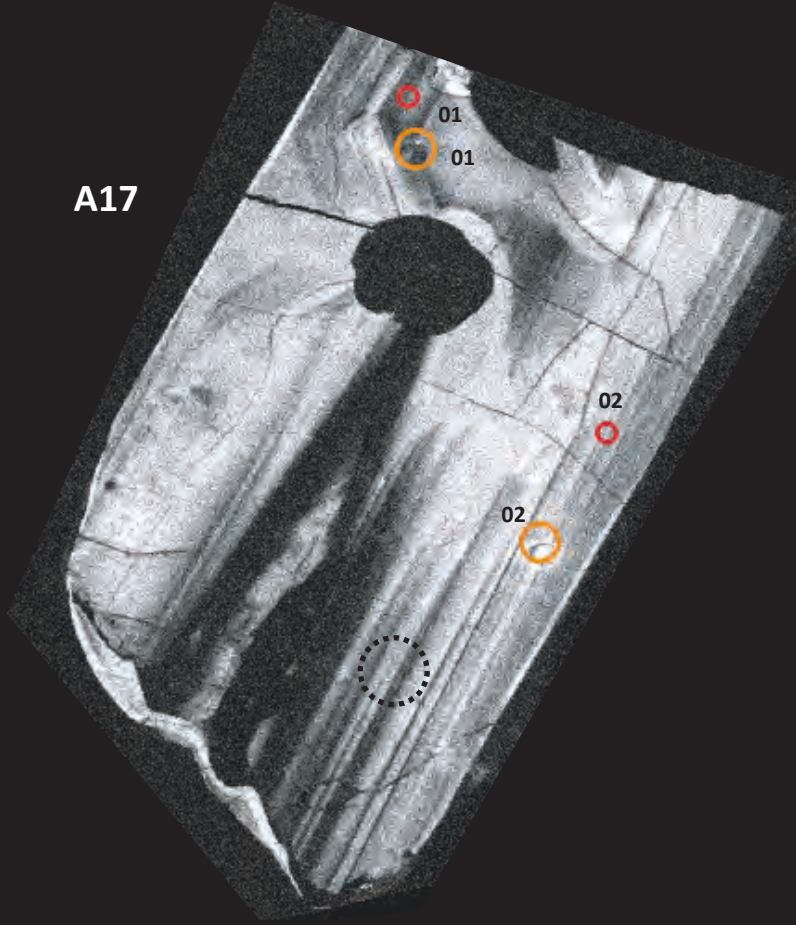
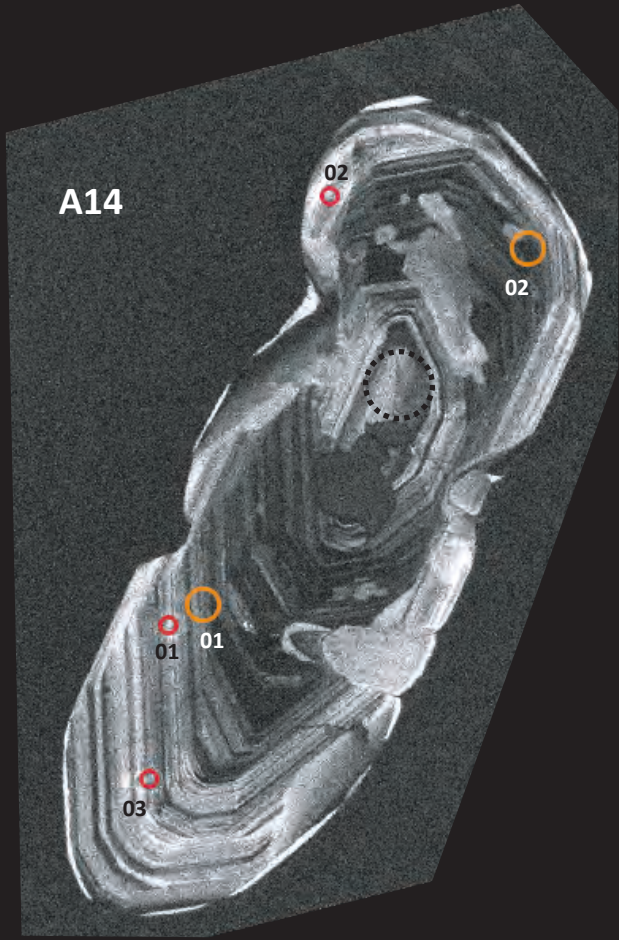
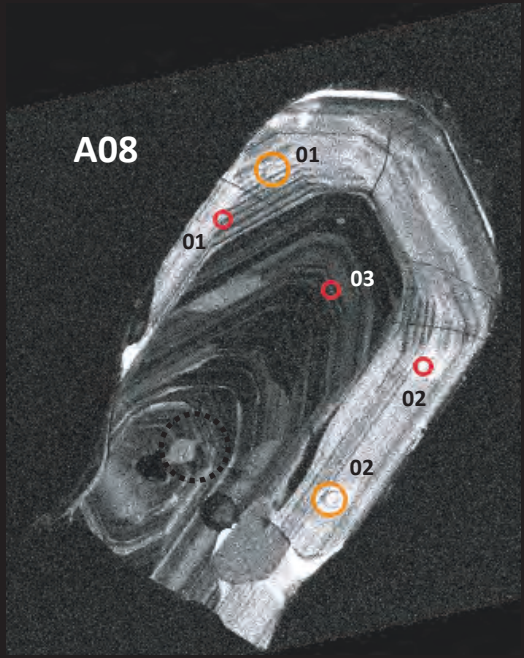
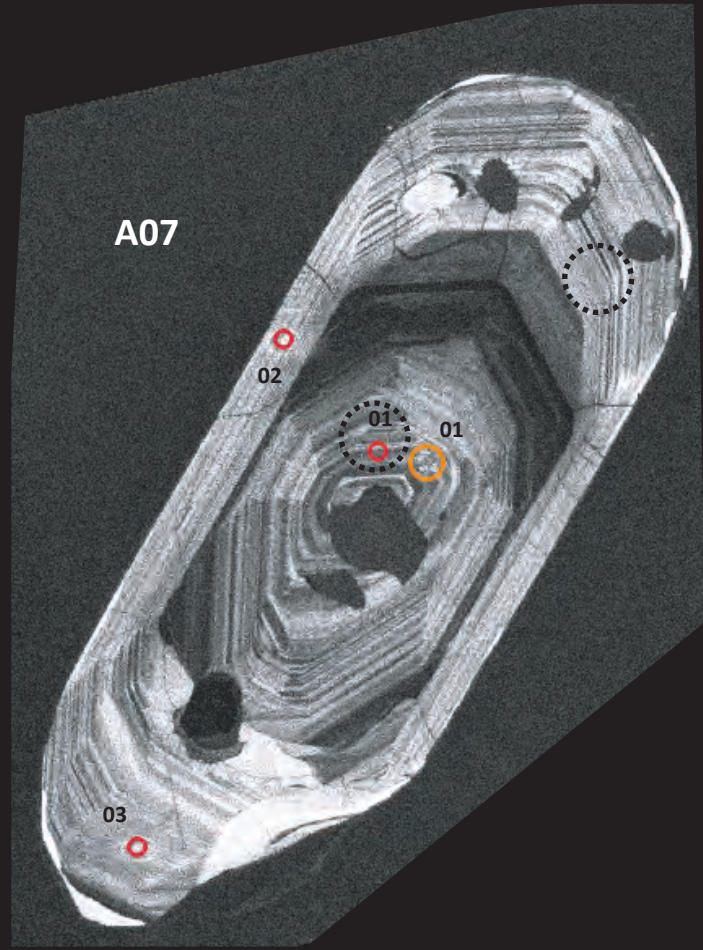
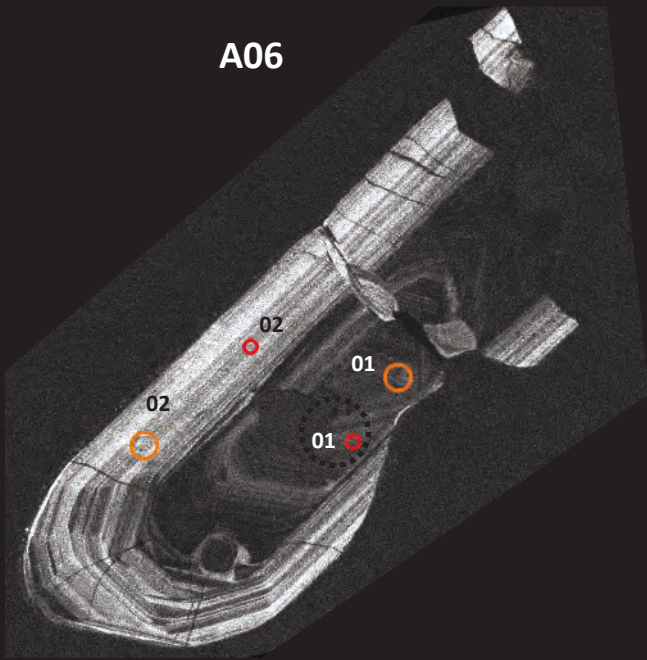
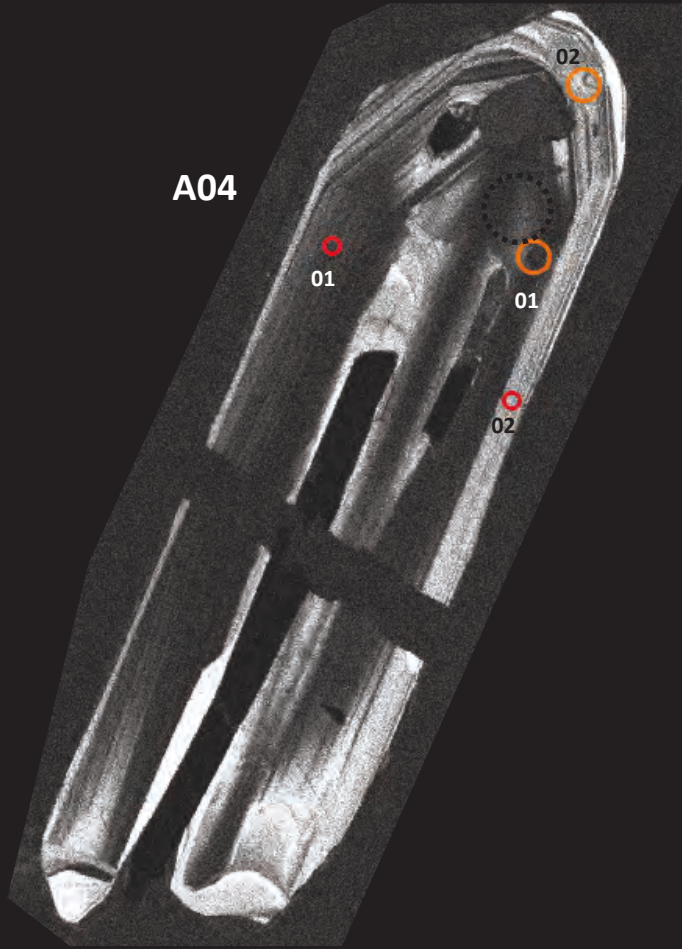
Approximate location
U-Pb/Lu-Hf ($\sim 40\ \mu\text{m}$)
(Wasilewski et al., 2021)





○ WiscSIMS O (~10 μm) ○ WiscSIMS TE (~12 μm) ○ Approximate location U-Pb/Lu-Hf (~40 μm) (Wasilewski et al., 2021)

100 μm



SG-127

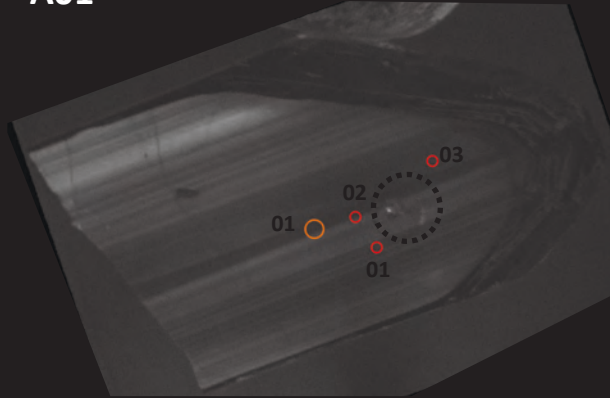
WiscSIMS O
(~10 μm)

WiscSIMS TE
(~12 μm)

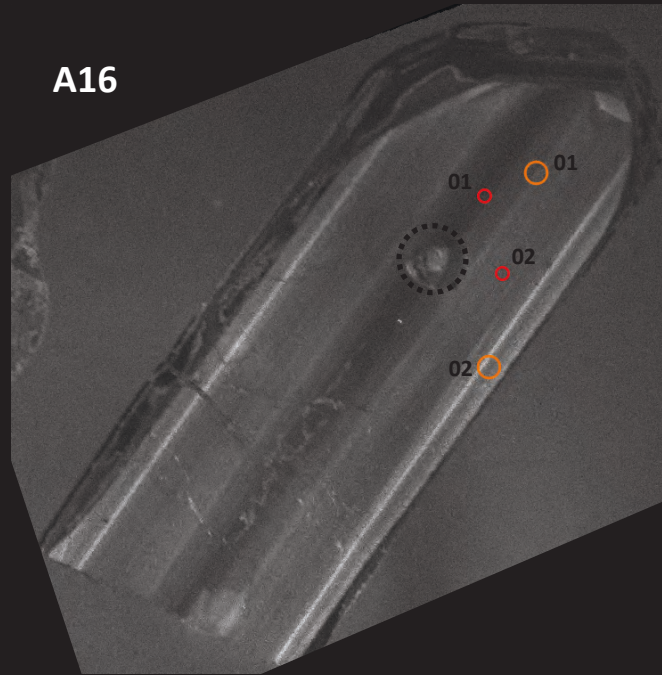
Approximate location
U-Pb/Lu-Hf (~40 μm)
(Wasilewski et al., 2021)

100 μm

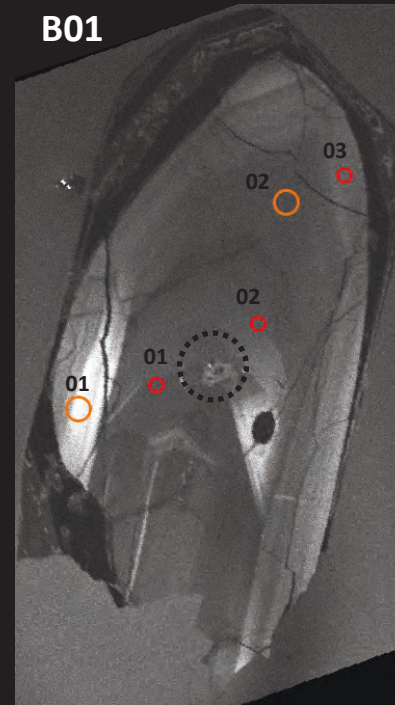
A01



A16



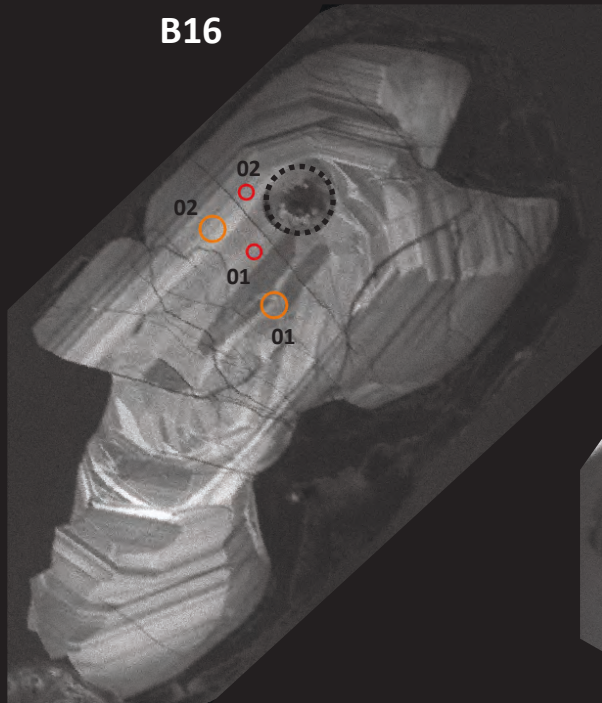
B01



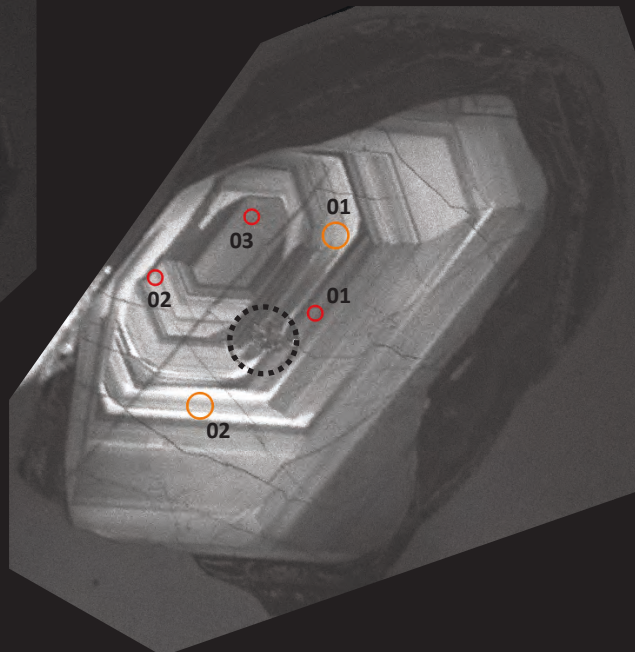
B11



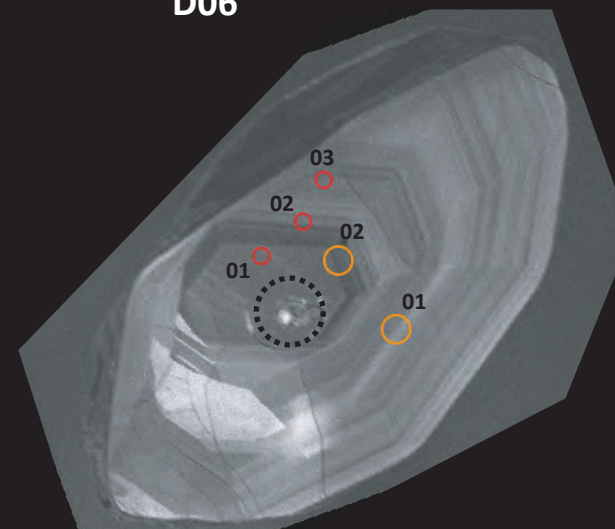
B16



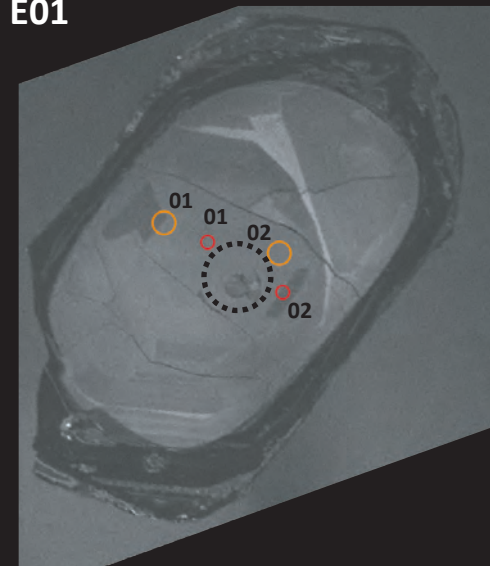
D04



D06



E01



Table

S1

S2

S3

S4

S5

Contents

Compiled and Correlated O and TE data (this study) along with U-Pb and Hf Isotope data (Wasilewski et al., 202
Raman data and alpha dose calculations for SG-027, SG-203, SG-265

WiscSIMS $\delta^{18}\text{O}$ Summary for Session 1 (06-2022)

WiscSIMS $\delta^{18}\text{O}$ Summary for Session 2 (11-2022)

WiscSIMS TE Summary (08-2022)

Supplemental Table S1: Compiled and Correlated O and TE data (this study)

blue text = screen OHO > 0.0002 alone

orange text = screen one or more Ca or Al > 20 ppm

purple text = screen both OHO and at least 1 TE screen

red = screened out on Fe > 20 ppm alone

cream background = metamorphic rim

$\delta^{18}\text{O}$ spot name	Reason for rejection
SG-210c-B17-1	
SG-210c-F09-2	
SG-210c-F14-2	
SG-210c-F09-1	
SG-210c-F13-2	
SG-210c-E17-1	
SG-210c-C06-1	
SG-210c-D11-2	
SG-210c-F10-03	
SG-210c-D17-2	
SG-210c-A15-2	
SG-210c-B15-2	
SG-210c-F01-1	
SG-210c-F13-4	
SG-210c-D11-1	
SG-210c-D10-2	
SG-210c-F05-2	
SG-210c-D17-1	
SG-210c-F01-2	
SG-210c-D08-3	
SG-210c-F05-1	
SG-210c-D10-1	
SG-210c-A15-1	
SG-210c-A01-3	
SG-210c-A15-3	
SG-210c-A15-4	
SG-210c-B15-1	
SG-210c-B17-2	
SG-210c-C06-2	
SG-210c-C08-2	
SG-210c-C10-2	
SG-210c-D08-1	
SG-210c-D08-2	
SG-210c-D10-3	
SG-210c-D11-3	
SG-210c-D17-3	
SG-210c-F09-3	

SG-210c-F10-01	
SG-210c-F10-02	
SG-210c-F10-04	
SG-210c-F13-1	
SG-210c-F13-3	
SG-210c-F14-1	
SG-210c-F14-3	
SG-210c-F14-4	
SG-210c-A01-1	Ca, Al, Fe
SG-210c-E17-2	Ca, Al, Fe
SG-210c-A01-2	OHO
SG-210c-C10-1	OHO
SG-210c-C08-1	OHO
SG-026-E04-1	
SG-026-A03-3	
SG-026-A03-4	
SG-026-D17-1	
SG-026-D17-3	
SG-026-F15-1	
SG-026-A03-2	
SG-026-F14-1	
SG-026-F14-3	
SG-026-F02-1	
SG-026-F15-3	
SG-026-F05-3	
SG-026-A07-1	
SG-026-B12-2	
SG-026-C15-3	
SG-026-F11-1	
SG-026-D17-2	
SG-026-B12-3	
SG-026-F09-2	
SG-026-D04-2	
SG-026-D13-1	
SG-026-A13-1	
SG-026-F15-2	
SG-026-A07-2	
SG-026-F02-2	
SG-026-E03-1	
SG-026-B14-3	
SG-026-F18-2	
SG-026-F09-3	
SG-026-F02-3	
SG-026-D04-1	

SG-026-B14-2
SG-026-C15-1
SG-026-A04-1
SG-026-A04-3
SG-026-E04-3
SG-026-A04-2
SG-026-C15-2
SG-026-C16-3
SG-026-E04-2
SG-026-E03-2
SG-026-D13-2
SG-026-F18-3
SG-026-B12-1
SG-026-C16-2
SG-026-B14-1
SG-026-F14-4
SG-026-F09-4
SG-026-F11-3
SG-026-A13-2
SG-026-F05-1
SG-026-F18-1
SG-026-A07-3
SG-026-A03-1
SG-026-A13-3
SG-026-D17-4
SG-026-F11-2
SG-026-F14-2
SG-026-C16-1
SG-026-F09-1
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SG-026-A04-4
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SG-122-D06-2
SG-122-E05-1
SG-122-C12-1
SG-122-C21-1
SG-122-C18-3
SG-122-E05-2
SG-122-E01-2
SG-122-C12-2
SG-122-B04-2
SG-122-C15-2
SG-122-C17-3
SG-122-B02-2

Fe
Ca, Al, Fe
Ca, Al, Fe
Ca, Al, Fe
OHO

SG-122-B02-1	
SG-122-B12-3	
SG-122-D02-2	
SG-122-B12-2	
SG-122-B02-3	
SG-122-C18-4	
SG-122-C17-1	
SG-122-E02-1	
SG-122-D06-1	Ca, Al, Fe
SG-122-E01-1	Ca, Al, Fe
SG-122-C21-2	Ca, Al, Fe
SG-122-C15-3	Ca, Al, Fe
SG-122-B04-1	Ca, Al, Fe
SG-122-C15-1	OHO, Ca, Al, Fe
SG-122-B12-1	OHO, Ca, Al, Fe
SG-122-C18-2	OHO,
SG-122-C01-1	OHO
SG-122-C17-2	OHO
SG-122-C01-2	OHO
SG-122-B01-2	OHO
SG-122-A17-1	OHO
SG-122-A17-2	OHO
SG-122-B01-1	OHO
SG-122-A17-3	OHO
SG-122-E02-2	OHO
SG-122-C12-3	OHO
SG-122-D02-1	OHO
SG-122-C15-4	OHO
SG-027-D07-1	
SG-027-D07-2	
SG-027-E11-02	
SG-027-C15-3	
SG-027-D17-1	
SG-027-F10-2	
SG-027-E04-2	
SG-027-B14-3	
SG-027-F10-3	
SG-027-C15-1	Fe
SG-027-D13-2	Fe
SG-027-F15-2	Fe
SG-027-F10-4	Fe
SG-027-C15-2	Ca, Al, Fe
SG-027-F10-1	Ca, Al, Fe

SG-027-E11-01	Ca, Al, Fe
SG-027-E04-1	Ca, Al, Fe
SG-027-F15-1	Ca, Al, Fe
SG-027-D17-3	OHO, Ca, Al, Fe
SG-027-B14-1	OHO, Ca, Al, Fe
SG-027-B14-2	OHO
SG-027-E04-3	OHO
SG-027-D17-2	OHO
SG-027-D13-1	OHO

SG-203-D07-2
 SG-203-A03-1
 SG-203-A06-2
 SG-203-B18-3
 SG-203-D12-2
 SG-203-B12-1
 SG-203-D12-1
 SG-203-A07-2
 SG-203-A02-1
 SG-203-D02-2
 SG-203-A02-2
 SG-203-B11-2
 SG-203-E15-2
 SG-203-C17-1
 SG-203-B18-1
 SG-203-B11-3
 SG-203-A12-1
 SG-203-F08-4
 SG-203-B18-2
 SG-203-B12-2
 SG-203-A12-2
 SG-203-A07-3
 SG-203-B12-3
 SG-203-A13-1
 SG-203-A04-3
 SG-203-E15-1
 SG-203-A04-2
 SG-203-C17-2
 SG-203-B11-1
 SG-203-A12-3
 SG-203-A03-2
 SG-203-A06-3
 SG-203-D02-1
 SG-203-D02-3
 SG-203-A04-4

SG-203-A07-1
SG-203-F08-2
SG-203-A02-3
SG-203-A13-2
SG-203-D12-3
SG-203-E15-3
SG-203-A06-1
SG-203-D07-3
SG-203-F08-3
SG-203-D07-1
SG-203-A04-1
SG-203-F08-1

Fe
Ca, Al, Fe
OHO
OHO
OHO
OHO
OHO

SG-265 -A02-180-2
SG-265 -A06-180-2
SG-265 -A07-180-2
SG-265 -A07-180-3
SG-265 -A08-180-2
SG-265 -A08-180-3
SG-265 -A14-180-1
SG-265 -A14-180-3
SG-265-A17-180-1
SG-265-A17-180-2
SG-265-B05-180-1
SG-265-B05-180-2
SG-265-B12-180-1
SG-265-B16-180-1
SG-265-B16-180-2
SG-265-B20-180-1
SG-265-C05-180-1
SG-265-C05-180-2
SG-265-C13-180-1
SG-265-C13-180-2
SG-265 -A04-180-2
SG-265 -A06-180-1
SG-265 -A07-180-1
SG-265 -A08-180-1
SG-265 -A14-180-2
SG-265 -A02-180-1
SG-265 -A04-180-1

Ca, Al, Fe
Ca, Al, Fe
Ca, Al, Fe
Ca, Al, Fe
Ca, Al, Fe
OHO, Ca, Al, Fe
OHO

SG-127-B01-1
SG-127-B16-2
SG-127-D04-2
SG-127-E01-2

SG-127-E01-1
SG-127-D04-1
SG-127-D06-1
SG-127-A16-3
SG-127-A01-1
SG-127-D06-2
SG-127-B11-1
SG-127-D04-3
SG-127-B01-2
SG-127-D06-3
SG-127-A01-2
SG-127-A01-3
SG-127-B16-1
SG-127-B01-3
SG-127-B11-3
SG-127-A16-1

Fe
Ca, Al, Fe
Ca, Al, Fe
OHO

ly) along with U-Pb and Hf Isot

Pit Image Notes

TE spot hit crack

O pit hit crack

O pit hit crack

O pit hit crack





O pit hit crack



O pit hit crack

O pit hit crack

O pit hit crack

O pit adjacent to fracture

O pit hit inclusion/dark debris

O pit adjacent to fracture

no noticeable features on O pit

O pit hit inclusion/dark debris

O pit hit inclusion/dark debris

no noticeable features on O pit

O pit hit inclusion/dark debris

O pit hit crack

O pit hit crack

O pit hit crack

O pit hit inclusion/dark debris

no noticeable features on O pit

no noticeable features on O pit

crack in bottom of O pit

O pit hit crack

O pit hit crack

no noticeable features on O pit



TE spot has crack

TE spot has crack

O pit hit crack

O pit hit crack

O pit hit crack

O pit hit inclusion

O pit hit crack



O pit hit crack

O pit hit crack



O pit hit crack

ope data (Wasilewski et al., 2021)

Zircon Texture Notes

osc zone core
osc zone core
edge of convoluted sector zone core
osc zone core (Hf spot)
sector core
osc zone core (Hf spot)
osc zone core
sector zone core; overlap with Hf spot
osc core (Hf spot)
osc zoned core
osc zoning on core
osc zone core
gray core (Hf spot)
osc rim (U-Pb but no Hf)
edge of sector zone core
zoned outer core
lighter osc zone rim (side of grain)
osc core/overlapping convoluted texture
osc zone rim (U-Pb but no Hf)
osc zone outer core
dark osc zone rim (Hf spot, top of grain)
core (Hf spot)
gray core (Hf spot)
dark rim
osc zone core
dark rim (U-Pb but no Hf spot)
osc zone core
osc zone core
osc zone core
light osc core
convoluted osc core
core next to Hf spot
core near annealed fracture
zoned outer core
osc zone core
osc zoned core
osc zone core

light gray core (Hf spot)
dark core (revealed by polish?)
osc core (outer of Hf spot)
sector core (near dark amorph feature)
sector core
convoluted sector zone core (Hf spot)
osc core
osc core
core (Hf spot)
osc zone core (across grain from Hf spot)
core (Hf spot)

3.7 Ga, low Th/U

light osc core

darker core (osc zone)
sector zoned mantle
sector zoned mantle
sector zoned core
sector zoned core
sector zoned
sector zoned core
sector zoned
sector zoned (osc zoned patch)
sector w/ internal osc
sector zoned
amorphous dark core zone (Hf spot)
sector zoned core
osc zoned core
sector zoned
sector zoned
sector zoned core
osc zoned core
sector zoned core
sector zoned core
sector zoned core
sector zoned core
sector zoned
sector zoned core
sector w/ internal osc
osc zoned
sector zoned core
sector zoned
sector zoned core
sector w/ internal osc
sector zoned core

sector zoned core
sector zoned
sector zoned core
sector zoned core
sector zoned
sector zoned core
sector zoned
sector zoned core
sector zoned
osc zoned
sector zoned core
sector zoned
osc zoned core
sector zoned core
sector zoned core
sector zoned
sector zoned core
sector zoned
sector zoned core
sector zoned
sector zoned
sector zoned core
sector zoned core
sector zoned core
sector zoned core
sector zoned
sector zoned

sector zoned

sector zoned core

sector zoned core

3.6 Ga age, low Th/U, sector zoned

black rim

osc zoned core

osc core

osc zoned core

osc zoned core

eq to C1 in Wasilewski

RIM

osc zoned core

osc zoned core

osc zoned core

osc zoned core

osc zoned core

osc zoned core

osc zoned core

osc zoned core
osc zoned rim
osc zoned core
osc zoned rim
osc zoned core

RIM

eq to C2 in Wasilewski

RIM

osc core
osc zoned core
osc zoned core
osc zoned core
osc zoned core
osc zoned core
osc zoned rim

RIM

dark
osc zoned core
dark
black core
dark core
dark core
black core
light osc rim
black inner rim
osc zoned core
osc zoned core

dark rim, low Th/U

core

core

RIM

RIM

core

core, low Th/U

zoned core

RIM

sector zoned mantle, low Th/U

core

core

sector core, highest d18O in dataset

sector zoned mantle

core

core

core
zoned core
sector core
sector core
dark core
dark core
still core?
sector core
core (possible crack?)



osc core, light
inner osc core (Hf spot)
zoned mantle/1st rim
osc rim (2nd Hf spot)
osc core
osc core (Hf spot)
osc core (Hf spot)
zoned 1st rim (Hf spot)
dark central core
osc zone core (Hf spot domain)
osc zone core (Hf spot)
osc zone (opp side of grain)
lighter core (osc zone)
osc/convoluted core (Hf spot)
osc core (Hf spot)
top of osc core (top of grain)
light core (Hf spot)
upper osc zone core (above fractures)
osc core (darker zone)
osc core
light core (Hf spot)
zoned 1st rim (Hf spot)
osc rim
osc rim (Hf spot)
osc zone core
core (Hf spot)
osc zone core
border of dark rim and osc zone
osc zone (Hf spot)
osc zone 1st rim
osc core (darker zone)
zoned mantle/1st rim
osc zone core (Hf spot domain)
osc zone core (near top of grain)
edge of osc core (darker zone)



light gray sector zone (Hf spot)

darker gray sector zone (same domain as Hf spot)

osc zone core (Hf spot, near crack)

gray core (Hf spot)

osc zone core (nearer to edge)

osc zone core (Hf spot)

darker zones on osc core

dark core (Hf spot)

osc zone inner core (darker zone)

gray core (just above Hf spot)

lighter zones on osc core

core

core

dark skinny core (just below Hf spot)

gray core (top part of grain (near crack?))

osc zone at edge of core

osc zone core (Hf spot)

$\delta^{18}\text{O}$ ‰ VSMOW	2SD (ext.)	2SE (int.)	16OH/16O bg-corrected	Relative Yield	Sample Age	
5.571	0.143	0.191	0.00000468	1.008	3869	
5.530	0.291	0.180	0.00010510	1.004	3869	
5.221	0.312	0.157	0.00001619	1.003	3869	
5.565	0.291	0.181	0.00012698	1.004	3869	
5.315	0.312	0.222	0.00003434	1.000	3869	
5.363	0.291	0.147	-0.00000672	1.006	3869	
5.415	0.143	0.141	0.00004539	1.000	3869	
5.496	0.176	0.132	0.00008193	1.006	3869	
5.233	0.312	0.146	0.00000283	0.996	3869	
5.565	0.291	0.121	0.00008165	1.003	3869	
5.710	0.143	0.213	0.00009099	1.005	3869	
5.509	0.143	0.156	0.00008040	1.004	3869	
5.385	0.291	0.221	0.00005998	1.004	3869	
5.472	0.312	0.151	0.00000351	1.000	3869	
5.448	0.176	0.124	0.00000285	1.006	3869	
5.508	0.176	0.169	0.00000579	1.003	3869	
5.505	0.291	0.150	0.00016142	1.004	3869	
5.428	0.291	0.195	0.00012090	1.007	3869	
5.408	0.291	0.239	0.00002137	0.998	3869	
5.586	0.176	0.180	0.00010061	1.000	3869	
5.280	0.291	0.195	0.00007261	1.001	3869	
5.115	0.176	0.156	0.00006670	1.004	3869	
5.625	0.143	0.211	0.00007252	1.003	3869	
5.352	0.143	0.203	0.00006303	1.004	3869	
5.095	0.143	0.165	0.00015425	1.005	3869	
5.627	0.143	0.128	0.00003788	1.002	3869	
5.630	0.143	0.131	0.00011612	1.007	3869	
5.602	0.143	0.198	0.00003677	1.019	3869	
5.351	0.176	0.164	-0.00001086	1.000	3869	
5.178	0.176	0.129	-0.00001167	1.006	3869	
5.972	0.176	0.184	0.00015952	1.007	3869	
5.237	0.176	0.158	0.00002956	1.004	3869	
5.692	0.176	0.160	0.00015334	1.001	3869	
5.722	0.176	0.167	0.00008477	1.003	3869	
5.479	0.176	0.174	0.00003396	1.003	3869	
5.390	0.291	0.219	0.00002982	1.005	3869	
5.034	0.291	0.200	0.00005785	1.006	3869	

5.371	0.312	0.225	0.00004537	1.008	3869
5.275	0.312	0.131	0.00000736	1.002	3869
5.074	0.312	0.140	0.00004393	1.000	3869
5.309	0.312	0.204	0.00000460	1.004	3869
5.334	0.312	0.182	0.00001217	0.996	3869
5.371	0.312	0.129	-0.00000320	1.003	3869
5.292	0.312	0.177	-0.00001589	1.002	3869
5.399	0.312	0.138	-0.00000789	1.005	3869
5.342	0.143	0.179	0.00004021	0.998	3869
6.030	0.291	0.181	0.00017325	1.008	3869
5.970	0.143	0.176	0.00035996	0.999	3869
5.718	0.176	0.176	0.00026897	1.009	3869
6.034	0.176	0.164	0.00021524	1.006	3869
6.293	0.294	0.199	0.00008490	1.018	3820
6.445	0.101	0.160	0.00005491	0.998	3820
6.582	0.101	0.142	0.00006015	1.000	3820
6.268	0.147	0.179	0.00004342	1.008	3820
6.275	0.294	0.172	0.00005922	0.999	3820
6.428	0.275	0.194	0.00004315	1.002	3820
6.589	0.101	0.256	0.00004384	1.000	3820
6.479	0.275	0.202	0.00003341	1.009	3820
5.284	0.275	0.179	0.00000878	1.003	3820
6.438	0.294	0.178	0.00003189	1.007	3820
6.500	0.275	0.164	0.00005694	1.001	3820
5.488	0.294	0.146	0.00017431	1.015	3820
6.549	0.101	0.168	0.00002820	1.002	3820
6.305	0.101	0.159	0.00004991	0.996	3820
6.375	0.147	0.187	0.00005919	1.003	3820
6.542	0.275	0.176	0.00006632	1.011	3820
6.231	0.147	0.180	0.00004050	1.003	3820
6.386	0.147	0.197	0.00003266	1.005	3820
6.381	0.294	0.178	0.00004680	1.008	3820
6.429	0.147	0.191	0.00004582	1.015	3820
6.515	0.147	0.144	0.00003757	1.008	3820
6.500	0.101	0.179	0.00003252	0.998	3820
6.444	0.275	0.170	0.00004144	1.005	3820
6.430	0.101	0.186	0.00002340	1.001	3820
6.619	0.294	0.145	0.00002633	1.012	3820
6.495	0.294	0.211	0.00002774	1.025	3820
6.329	0.147	0.191	0.00002874	1.003	3820
6.533	0.275	0.233	0.00002946	1.004	3820
6.306	0.294	0.178	0.00003049	1.010	3820
6.330	0.294	0.173	0.00003171	1.012	3820
6.344	0.147	0.127	0.00003551	1.012	3820

6.319	0.147	0.119	0.00003727	1.004	3820
6.344	0.147	0.189	0.00004207	1.008	3820
6.548	0.101	0.176	0.00004237	1.004	3820
6.581	0.101	0.213	0.00004253	1.012	3820
6.487	0.294	0.182	0.00004286	1.017	3820
6.710	0.101	0.184	0.00004307	0.999	3820
6.251	0.147	0.183	0.00004481	1.007	3820
6.329	0.147	0.208	0.00004520	0.998	3820
6.352	0.294	0.165	0.00004563	1.013	3820
6.478	0.294	0.168	0.00004632	1.021	3820
6.234	0.147	0.176	0.00004893	1.005	3820
6.396	0.275	0.208	0.00005111	1.001	3820
6.334	0.101	0.191	0.00005309	1.000	3820
6.640	0.147	0.168	0.00005327	1.003	3820
6.375	0.147	0.164	0.00005748	1.002	3820
6.458	0.275	0.182	0.00005807	0.349	3820
6.246	0.275	0.201	0.00006045	1.011	3820
6.583	0.275	0.171	0.00006186	1.007	3820
6.420	0.101	0.148	0.00006326	0.995	3820
6.422	0.294	0.187	0.00006892	1.016	3820
6.078	0.275	0.159	0.00006966	1.009	3820
6.486	0.101	0.143	0.00007655	0.998	3820
6.424	0.101	0.177	0.00007804	1.003	3820
6.204	0.101	0.174	0.00007836	0.994	3820
6.438	0.294	0.161	0.00007862	1.002	3820
6.121	0.275	0.226	0.00013808	1.010	3820
6.505	0.275	0.201	0.00005483	1.009	3820
6.757	0.147	0.206	0.00004612	1.003	3820
6.526	0.294	0.226	0.00004168	1.012	3820
6.411	0.294	0.150	0.00003155	1.011	3820
5.970	0.101	0.195	0.00021194	1.015	3820
5.758	0.144	0.209	0.00002358	1.006	3781
5.812	0.144	0.147	0.00005429	1.006	3781
5.747	0.144	0.129	0.00010764	1.012	3781
5.652	0.215	0.163	0.00012032	1.008	3781
5.359	0.144	0.146	0.00015091	1.008	3781
6.366	0.144	0.185	0.00018776	1.012	2804
5.744	0.144	0.210	0.00000248	1.008	3781
5.618	0.144	0.175	0.00001347	1.008	3781
5.866	0.215	0.127	0.00004890	1.007	3781
5.606	0.238	0.167	0.00005046	1.007	3781
5.825	0.215	0.170	0.00006004	1.005	3781
6.229	0.215	0.183	0.00007396	1.009	3781
5.704	0.238	0.149	0.00008048	1.006	3781

5.679	0.238	0.197	0.00008140	1.009	3781
5.486	0.238	0.206	0.00008605	1.007	3781
5.725	0.144	0.184	0.00010184	1.007	3781
5.578	0.238	0.142	0.00010740	1.005	3781
5.442	0.238	0.149	0.00012571	1.006	3781
6.211	0.144	0.187	0.00012707	1.009	2804
5.584	0.215	0.175	0.00013533	1.001	3781
6.388	0.144	0.188	0.00014448	1.012	2804
5.795	0.144	0.172	0.00002280	1.013	3781
5.882	0.144	0.116	0.00007603	1.008	3781
5.971	0.144	0.215	0.00005487	1.001	3781
5.595	0.215	0.172	0.00002830	1.009	3781
5.619	0.238	0.179	0.00008975	1.005	3781
5.784	0.215	0.156	0.00032930	1.015	3781
5.635	0.238	0.164	0.00025403	1.007	3781
6.023	0.144	0.112	0.00020783	1.010	2804
7.257	0.215	0.191	0.00021419	1.016	3781
6.017	0.215	0.157	0.00023055	1.013	3781
7.071	0.215	0.151	0.00023787	1.014	3781
6.490	0.238	0.148	0.00026703	1.019	3781
5.234	0.238	0.202	0.00027330	1.018	3781
5.413	0.238	0.154	0.00028133	1.011	3781
6.235	0.238	0.216	0.00029714	1.025	3781
5.370	0.238	0.193	0.00036846	1.006	3781
5.972	0.144	0.152	0.00041169	1.016	3781
5.564	0.215	0.177	0.00049934	1.017	3781
5.575	0.144	0.175	0.00071699	1.020	3781
5.073	0.215	0.153	0.00209565	1.017	3781
8.207	0.296	0.190	0.00000886	0.989	3632
8.157	0.154	0.210	0.00008470	1.005	3632
8.290	0.154	0.169	0.00014889	1.017	2785
7.834	0.296	0.162	0.00014120	1.006	2785
8.357	0.296	0.140	0.00017491	1.006	3632
8.038	0.154	0.199	0.00018861	1.021	3632
7.912	0.154	0.151	0.00019485	1.015	3632
7.820	0.296	0.189	0.00019637	1.012	2785
8.196	0.154	0.202	0.00019867	1.015	3632
8.388	0.296	0.153	0.00014733	1.002	3632
8.201	0.296	0.169	0.00016700	0.999	3632
8.843	0.154	0.170	0.00016690	1.021	3632
8.245	0.154	0.174	0.00014594	1.010	3632
7.930	0.296	0.160	0.00017270	0.994	3632
8.358	0.154	0.190	0.00014285	1.011	3632

8.102	0.154	0.209	0.00016595	1.025	3632
8.026	0.154	0.108	0.00016715	1.018	3632
8.353	0.154	0.215	0.00017010	1.020	3632
8.071	0.296	0.242	0.00020907	0.998	3632
8.057	0.296	0.165	0.00020540	1.007	3632
8.060	0.296	0.193	0.00020289	1.000	3632
7.973	0.154	0.169	0.00020986	1.007	3632
7.967	0.296	0.175	0.00021900	1.005	3632
8.271	0.296	0.148	0.00021364	1.005	3632

8.036	0.375	0.135	-0.00000293	1.007	3330
7.785	0.163	0.188	-0.00000419	0.997	3330
8.013	0.163	0.162	0.00004624	1.003	3330
7.477	0.331	0.174	0.00008071	1.006	3330
7.817	0.375	0.140	0.00001073	1.011	3330
7.724	0.331	0.163	-0.00003765	0.999	3330
8.119	0.375	0.130	-0.00000384	1.006	3330
8.099	0.163	0.201	0.00003337	0.999	3330
7.630	0.163	0.152	0.00008435	0.995	3330
7.888	0.331	0.165	-0.00000162	0.996	3330
7.852	0.163	0.136	0.00001426	0.997	3330
7.690	0.331	0.173	0.00002094	1.005	3330
7.826	0.375	0.151	-0.00001353	0.999	3330
7.716	0.331	0.229	0.00000923	0.998	3330
7.622	0.331	0.197	0.00002938	1.002	3330
7.724	0.331	0.236	0.00005376	1.007	3330
7.740	0.163	0.205	-0.00000592	1.003	3330
7.618	0.375	0.174	0.00006930	1.000	3330
7.677	0.331	0.161	-0.00003231	1.001	3330
7.658	0.331	0.171	-0.00003066	0.999	3330
7.557	0.163	0.186	-0.00001724	1.002	3330
8.167	0.163	0.190	-0.00001694	1.014	3330
7.564	0.331	0.179	-0.00000702	1.003	3330
7.626	0.331	0.213	-0.00000689	0.998	3330
8.021	0.163	0.192	-0.00000154	1.001	3330
7.655	0.375	0.175	0.00001998	1.002	3330
7.495	0.163	0.177	0.00002174	0.995	3330
7.749	0.331	0.133	0.00002407	1.003	3330
7.436	0.331	0.166	0.00002632	1.001	3330
8.039	0.331	0.202	0.00004155	0.989	3330
7.896	0.163	0.203	0.00005100	1.002	3330
7.768	0.163	0.174	0.00005676	1.003	3330
7.390	0.331	0.119	0.00006530	0.992	3330
7.570	0.375	0.139	0.00009309	1.001	3330
7.544	0.163	0.153	0.00011932	1.005	3330

7.992	0.163	0.185	0.00012154	1.000	3330
7.596	0.375	0.180	0.00013467	1.003	3330
7.539	0.163	0.202	0.00013515	1.000	3330
7.183	0.331	0.195	0.00013850	1.005	3330
7.279	0.375	0.188	0.00017209	0.998	3330
7.804	0.375	0.143	0.00000230	0.996	3330
7.934	0.163	0.179	0.00000348	1.001	3330
7.507	0.375	0.198	0.00027227	1.003	3330
7.610	0.375	0.175	0.00038313	0.999	3330
6.897	0.375	0.151	0.00025339	0.986	3330
6.112	0.163	0.180	0.00027862	1.038	3330
6.133	0.375	0.176	0.00198271	1.021	3330

5.576	0.152	0.214	-0.00002365	1.002	3200
5.596	0.152	0.202	-0.00002161	1.008	3200
5.576	0.152	0.209	0.00000482	1.005	3200
5.625	0.152	0.165	-0.00002400	0.997	3200
5.783	0.152	0.199	-0.00003991	0.997	3200
5.835	0.152	0.200	-0.00001367	1.000	3200
5.871	0.152	0.148	-0.00000300	1.001	3200
5.596	0.152	0.183	0.00001655	1.000	3200
5.676	0.139	0.211	-0.00003412	0.998	3200
5.720	0.139	0.158	0.00003882	1.008	3200
5.592	0.139	0.137	-0.00002432	1.007	3200
5.771	0.139	0.198	0.00001365	1.001	3200
5.541	0.139	0.166	-0.00001600	1.008	3200
5.606	0.139	0.205	0.00011334	1.004	3200
5.714	0.139	0.129	-0.00001633	1.003	3200
5.549	0.139	0.171	-0.00002799	1.009	3200
5.788	0.139	0.226	-0.00000434	1.006	3200
5.802	0.139	0.193	-0.00000401	1.005	3200
5.750	0.139	0.171	-0.00000999	1.003	3200
5.614	0.139	0.134	-0.00000834	0.999	3200
5.575	0.152	0.200	0.00006673	1.003	3200
5.668	0.152	0.201	0.00007308	1.001	3200
5.872	0.152	0.213	-0.00000040	1.003	3200
5.656	0.152	0.192	-0.00004394	0.999	3200
5.647	0.152	0.191	-0.00000202	1.009	3200
5.574	0.152	0.127	0.00028958	1.011	3200
5.387	0.152	0.166	0.00020818	1.009	3200

6.671	0.242	0.208	0.00012660	1.010	2789
6.469	0.208	0.181	-0.00001128	1.006	2789
7.057	0.242	0.202	0.00003185	0.990	2789
6.271	0.242	0.194	0.00008962	1.011	2789

6.198	0.242	0.193	0.00005302	1.011	2789
6.952	0.242	0.205	0.00004690	1.007	2789
6.999	0.208	0.167	0.00004396	1.014	2789
6.809	0.208	0.198	0.00008815	1.003	2789
6.501	0.242	0.160	0.00014798	1.009	2789
7.194	0.208	0.167	0.00008857	1.014	2789
6.718	0.208	0.127	0.00010025	1.014	2789
6.627	0.208	0.193	0.00002559	1.016	2789
6.856	0.242	0.172	0.00007567	1.009	2789
6.981	0.208	0.225	0.00009177	1.012	2789
6.475	0.242	0.192	0.00015040	1.004	2789
6.612	0.242	0.152	0.00019149	0.998	2789
6.099	0.208	0.193	-0.00001460	1.009	2789
6.554	0.242	0.191	0.00011395	1.007	2789
6.411	0.208	0.200	0.00010852	1.014	2789
6.989	0.208	0.186	0.00020349	1.015	2789

1000

1000

1000

Sample ϵ_{Hf}

Th/U (Wasilewski et al., 2021)

1.81	0.49
1.81	0.59
1.81	0.36
1.81	0.59
1.81	0.32
1.81	0.11
1.81	0.51
1.81	0.29
1.81	0.38
1.81	0.32
1.81	0.51
1.81	0.41
1.81	0.33
1.81	0.3
1.81	0.29
1.81	0.42
1.81	0.26
1.81	0.32
1.81	0.26
1.81	0.59
1.81	0.26
1.81	0.42
1.81	0.51
1.81	0.29
1.81	0.51
1.81	0.22
1.81	0.41
1.81	0.49
1.81	0.51
1.81	0.35
1.81	0.03
1.81	0.59
1.81	0.59
1.81	0.42
1.81	0.29
1.81	0.32
1.81	0.59

1.81	0.38
1.81	0.38
1.81	0.38
1.81	0.32
1.81	0.32
1.81	0.36
1.81	0.36
1.81	0.36
1.81	0.53
1.81	0.11
1.81	0.53
1.81	0.03
1.81	0.35

3.7	1.05
3.7	1.02
3.7	1.02
3.7	1.54
3.7	1.54
3.7	1.1
3.7	1.02
3.7	1.01
3.7	1.01
3.7	1.35
3.7	1.1
3.7	0.94
3.7	1.4
3.7	0.88
3.7	1.02
3.7	1.09
3.7	1.54
3.7	0.88
3.7	1.31
3.7	1.1
3.7	1.58
3.7	0.82
3.7	1.1
3.7	1.4
3.7	1.35
3.7	1.49
3.7	1.07
3.7	1.12
3.7	1.31
3.7	1.35
3.7	1.1

3.7	1.07
3.7	1.02
3.7	1.2
3.7	1.2
3.7	1.05
3.7	1.2
3.7	1.02
3.7	1.17
3.7	1.05
3.7	1.49
3.7	1.58
3.7	1.12
3.7	0.88
3.7	1.17
3.7	1.07
3.7	1.01
3.7	1.31
3.7	1.09
3.7	0.82
3.7	0.02
3.7	1.12
3.7	1.4
3.7	1.02
3.7	0.82
3.7	1.54
3.7	1.09
3.7	1.01
3.7	1.17
3.7	1.31
3.7	0.02
3.7	0.1
1.7	0.2
1.7	0.17
1.7	0.16
1.7	0.21
1.7	0.2
	0.16
1.7	0.16
1.7	0.29
1.7	0.21
1.7	0.3
1.7	0.24
1.7	0.25
1.7	0.18

1.7	0.18
1.7	0.19
1.7	0.17
1.7	0.19
1.7	0.18
	0.16
1.7	0.48
	0.19
1.7	0.17
1.7	0.29
1.7	0.31
1.7	0.24
1.7	0.3
1.7	0.24
1.7	0.19
	0.16
1.7	0.06
1.7	0.48
1.7	0.06
1.7	0.15
1.7	0.09
1.7	0.09
1.7	0.15
1.7	0.25
1.7	0.13
1.7	0.21
1.7	0.17
1.7	0.04
-1.1	0.39
-1.1	0.39
	0.02
	0.03
-1.1	0.29
-1.1	0.3
-1.1	0.38
	0.03
-1.1	0.3
-1.1	0.29
-1.1	0.26
-1.1	0.3
-1.1	0.3
	0.29
-1.1	0.3

-1.1	0.08
-1.1	0.38
-1.1	0.3
-1.1	0.29
-1.1	0.25
-1.1	0.25
-1.1	0.38
-1.1	0.29
-1.1	0.26



-6.3	0.56
-6.3	0.64
-6.3	0.67
-6.3	0.44
-6.3	0.48
-6.3	0.7
-6.3	0.48
-6.3	0.51
-6.3	0.22
-6.3	0.68
-6.3	0.22
-6.3	0.39
-6.3	0.49
-6.3	0.38
-6.3	0.32
-6.3	0.39
-6.3	0.41
-6.3	0.52
-6.3	0.32
-6.3	0.7
-6.3	0.41
-6.3	0.51
-6.3	
-6.3	0.47
-6.3	0.76
-6.3	0.49
-6.3	0.76
-6.3	
-6.3	0.39
-6.3	0.41
-6.3	0.64
-6.3	0.67
-6.3	0.68
-6.3	0.68
-6.3	0.76

-6.3	
-6.3	0.52
-6.3	0.22
-6.3	
-6.3	0.48
-6.3	0.49
-6.3	0.67
-6.3	0.56
-6.3	0.52
-6.3	0.56
-6.3	0.76
-6.3	0.52

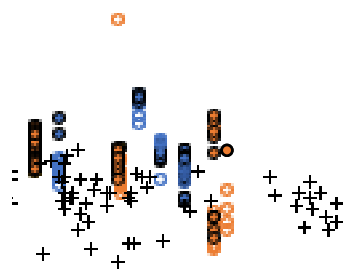


1	0.27
1	0.29
1	0.23
1	0.23
1	0.19
1	0.19
1	0.25
1	0.25
1	0.17
1	0.17
1	0.22
1	0.22
1	0.31
1	0.35
1	0.35
1	0.26
1	0.22
1	0.22
1	0.31
1	0.31
1	0.28
1	0.29
1	0.4
1	0.19
1	0.25
1	0.27
1	0.28



-12.2	0.8
-12.2	0.69
-12.2	0.87
-12.2	0.25

-12.2	0.25
-12.2	0.87
-12.2	0.48
-12.2	1.4
-12.2	0.39
-12.2	0.48
-12.2	0.33
-12.2	0.87
-12.2	0.8
-12.2	0.48
-12.2	
-12.2	
-12.2	0.69
-12.2	0.8
-12.2	0.33
-12.2	1.4



207Pb/206Pb spot (Wasilewski et al., 2021)	2s	% conc
3878	47	100
3875	48	99
3846	49	98
3875	48	99
3882	48	100
3807	47	98
3869	47	100
3879	48	100
3884	48	99
3857	49	100
3863	49	100
3878	47	100
3872	48	100
3813	49	94
3879	48	100
3872	48	100
3842	48	99
3857	49	100
3830	48	97
3878	48	100
3842	48	99
3872	48	100
3863	49	100
3781	47	98
3863	49	100
3848	49	101
3878	47	100
3878	47	100
3869	47	100
3898	48	100
3575	48	99
3877	48	100
3877	48	100
3872	48	100
3879	48	100
3857	49	100
3875	48	99

3882	48	99
3883	48	99
3885	48	99
3882	48	100
3882	48	100
3846	49	98
3846	49	98
3846	49	98
3858	47	101
3807	47	98
3858	47	101
3575	48	99
3898	48	100
3775	47	99
3727	47	99
3727	47	99
3738	47	98
3738	47	98
3755	48	98
3727	47	99
3617	48	94
3617	48	94
3736	47	97
3755	48	98
3744	47	97
3746	47	98
3620	48	95
3702	49	95
3739	48	97
3738	47	98
3620	48	95
3745	47	97
3712	48	97
3672	47	95
3694	47	98
3755	48	98
3746	47	98
3736	47	97
3744	47	98
3709	48	97
3732	48	97
3745	47	97
3736	47	97
3712	48	97

3709	48	97
3702	49	95
3725	47	99
3725	47	99
3775	47	99
3725	47	99
3702	49	95
3700	48	97
3775	47	99
3744	47	98
3672	47	95
3732	48	97
3620	48	95
3700	48	97
3709	48	97
3617	48	94
3745	47	97
3739	48	97
3694	47	98
3673	47	96
3732	48	97
3746	47	98
3727	47	99
3694	47	98
3738	47	98
3739	48	97
3617	48	94
3700	48	97
3745	47	97
3673	47	96
3639	47	97
3703	47	100
3703	48	88
3700	50	91
3712	47	98
3717	47	100
2801	51	100
3700	50	91
3646	49	96
3712	47	98
3652	47	99
3712	47	99
3612	47	95
3723	47	95

	3723	47	95
	3782	47	99
	3719	47	97
	3782	47	99
	3723	47	95
	2801	51	100
	3652	47	98
	2801	51	99
	3703	48	88
	3646	49	96
	3647	48	99
	3712	47	99
	3652	47	99
	3712	47	99
	3782	47	99
	2801	51	100
	3602	47	97
	3652	47	98
	3602	47	97
	3631	46	100
	3722	46	97
	3722	46	97
	3631	46	100
	3523	48	88
	3669	47	97
	3712	47	98
	3719	47	97
	3435	47	88
	3557	46	100
	3557	46	100
	2750	50	99
	2786	50	100
	3599	47	100
	3562	47	100
	2704	51	100
	3565	46	99
	3569	46	100
	3541	47	100
	2786	50	100
	3599	47	100

3236	48	98
3562	47	100
3541	47	100
3505	47	100
3583	47	98
3583	47	98

3505	47	100
3569	46	100



3320	49	100
3314	49	101
3331	49	100
3326	51	100
3327	51	100
3326	51	100
3341	49	100
3356	48	100

3356	48	100
3296	51	98
3329	51	100
3309	51	99
3113	51	100
3296	51	98
3303	50	99
3321	52	100
3113	51	100
3327	51	100
3303	50	99
3341	49	100

3355	49	100
3341	49	101
3329	51	100
3340	49	101

3296	51	98
3303	50	99
3320	49	100
3314	49	101

3312	50	100
3342	49	101

3321	52	100
3356	48	100

3326	51	100
3329	51	100
3314	49	101

3321	52	100
3339	49	101
3321	52	100

3211	52	98
3212	52	98
3227	53	99
3227	53	99
3205	53	99
3205	53	99
3222	50	98
3222	50	98
3234	51	100
3234	51	100
3221	49	99
3221	49	99
3225	50	100
3221	49	100
3221	49	100
3223	50	100
3223	50	100
3223	50	100
3221	50	100
3221	50	100
3213	52	99
3212	52	98
3197	53	96
3205	53	99
3222	50	98
3211	52	98
3213	52	99

2805	51	99
2769	53	99
2801	53	99
2808	51	98

2808	51	98
2801	53	99
2804	53	98
2808	51	100
2789	51	100
2804	53	98
2802	52	98
2801	53	99
2805	51	99
2804	53	98

2769	53	99
2805	51	99
2802	52	98
2808	51	100

ϵ Hf spot (Wasilewski et al., 2021)	2s	TE spot name	^{27}Al
2.6	1	SG-210c-B17-TE-1	2.3
1.3	0.7	SG-210c-F09-TE-2	1.7
0.5	1.5	SG-210c-F14-TE-1	1.7
1.3	0.7	SG-210c-F09-TE-1	1.8
0.2	1.1	SG-210c-F13-TE-1	2.0
0.2	0.7	SG-210c-E17-TE-1	1.5
4.7	0.9	SG-210c-C06-TE-1	1.6
2.6	1.5	SG-210c-D11-TE-2	1.6
2.2	0.9	SG-210c-F10-TE-1	1.7
0.8	1.2	SG-210c-D17-TE-2	1.9
0.2	1	SG-210c-A15-TE-2	4.7
2	0.9	SG-210c-B15-TE-1	2.2
1.5	0.9	SG-210c-F01-TE-1	4.2
		SG-210c-F13-TE-2	4.3
2.6	1.5	SG-210c-D11-TE-1	2.4
2	0.8	SG-210c-D10-TE-2	2.9
0.5	0.8	SG-210c-F05-TE-2	2.3
0.8	1.2	SG-210c-D17-TE-1	2.6
1.5	0.9	SG-210c-F01-TE-2	17.7
0.3	1.2	SG-210c-D08-TE-1	2.5
0.5	0.8	SG-210c-F05-TE-1	17.8
2	0.8	SG-210c-D10-TE-1	1.7
0.2	1	SG-210c-A15-TE-1	1.5
5.3	0.8		
0.2	1		
2	0.9		
2.6	1		
4.7	0.9		
4.1	1.2		
1.1	0.5		
0.2	1.1		
0.2	1.1		
2	0.8		
2.6	1.5		
0.8	1.2		
1.3	0.7		

2	0.7		
2.1	0.8		
2.3	0.1		
0.2	1.1		
0.2	1.1		
0.5	1.5		
0.5	1.5		
0.5	1.5		
0.8	0.9	SG-210c-A01-TE-1	29.6
0.2	0.7	SG-210c-E17-TE-2	83.4
0.8	0.9	SG-210c-A01-TE-2	6.8
1.1	0.5		
4.1	1.2	SG-210c-C08-TE-1	1.1
2.3	1.1	SG-026-E04-2	2.4
0.8	0.9	SG-026-A03-2	5.0
0.8	0.9		3.5
1.7	0.7	SG-026-D17-1	2.5
1.7	0.7	SG-026-E04-1	2.8
2.8	0.9	SG-026-F15-1	2.4
0.8	0.9	SG-026-A03-1	2.8
-1.3	1	SG-026-F14-1	4.7
-1.3	1	SG-026-F14-3	7.8
		SG-026-F02-1	2.7
2.8	0.9	SG-026-F15-3	10.3
		SG-026-F05-2	3.0
0.8	1.1	SG-026-A07-1	2.8
-1.6	0.8	SG-026-B12-1	3.5
-0.7	0.9	SG-026-C15-1	3.9
1.5	1.1	SG-026-F11-1	2.9
1.7	0.7	SG-026-D17-2	2.1
-1.6	0.8		4.4
		SG-026-F09-2	9.0
		SG-026-D04-1	5.0
		SG-026-D13-1	4.1
-0.4	0.7	SG-026-A13-1	2.7
2.8	0.9	SG-026-F15-2	2.6
0.8	1.1		
1.7	1.1		
0.5	1		

0.5	1
-0.7	0.9
1.6	0.9 SG-026-A04-1
1.6	0.9
2.3	1.1
1.6	0.9
-0.7	0.9

2.3	1.1
1.7	1.1

-1.6	0.8
------	-----

0.5	1 SG-026-B14-1
-1.3	1

1.5	1.1
-0.4	0.7

0.8	1.1
0.8	0.9
-0.4	0.7
1.7	0.7
1.5	1.1

-1.3	1 SG-026-F14-2	9.5
	SG-026-C16-1	10.5
	SG-026-F09-1	90.0
	SG-026-F05-1	25.7

-1.3	0.8 SG-122-C18-1	2.1
	SG-122-D06-2	3.6
1.1	0.6 SG-122-E05-1	6.5
0.4	0.6 SG-122-C12-1	10.5
-1.2	0.6 SG-122-C21-1	17.2
-11.3	0.6 SG-122-C18-3	2.9

1.1	0.6
-1.7	0.6
0.4	0.6
-1.6	0.7
-0.1	0.6
-1.7	0.6
-0.3	0.7

	-0.3	0.7		
	0.5	0.8		
	-0.3	0.6		
	0.5	0.8		
	-0.3	0.7		
	-11.3	0.6		
	-1.7	0.6		
	-10.9	0.7		
		SG-122-D06-1		11.0
	-1.7	0.6	SG-122-E01-1	61.9
	-1.2	0.6	SG-122-C21-2	40.0
	-0.1	0.6	SG-122-C15-2	83.5
	-1.6	0.7	SG-122-B04-1	465.9
	-0.1	0.6	SG-122-C15-1	106.2
	0.5	0.8	SG-122-B12-1	40.1
	-11.3	0.6	SG-122-C18-2	5.6
	-2.4	0.9		
	-1.7	0.6		
	-2.4	0.9		
	-0.6	0.8		
	-1.3	0.7		
	-1.3	0.7		
	-0.6	0.8		
	-1.3	0.7		
	0.5	0.7		
	0.4	0.6		
	-0.3	0.6		
	-4.2	0.8	SG-027-D07-1	2.3
	-4.2	0.8	SG-027-D07-2	2.1
	-14.4	0.9	SG-027-E11-2	3.3
	-15.3	0.5		
	-1.3	0.9		
	-3.4	0.9		
	-18.6	1		
	-2.7	0.6	SG-027-C15-1	11.4
	-2.7	0.9	SG-027-D13-1	17.7
	-3.7	1.1	SG-027-F15-2	19.5
		SG-027-F10-2		13.4
	-15.3	0.5	SG-027-C15-2	101.3
	-1.3	0.9	SG-027-F10-1	22.7

-9.8	0.9	SG-027-E11-1	44.8
-3.4	0.9	SG-027-E04-1	31.2
-3.7	1.1	SG-027-F15-1	57.3
-5.3	1.1	SG-027-D17-2	28.1
-2.9	0.8	SG-027-B14-1	68.1
-2.9	0.8	SG-027-B14-2	7.9
		SG-027-E04-2	7.1
-5.3	1.1	SG-027-D17-1	11.8
-2.7	0.9		

		SG-203-D07-1	1.2
-7.1	0.8	SG-203-A03-1	1.2
-7	0.6	SG-203-A06-2	1.0
-6.5	1	SG-203-B18-2	1.3
-6.5	0.7	SG-203-D12-2	1.4
-6.1	1.2	SG-203-B12-1	2.0
-6.5	0.7	SG-203-D12-1	1.6
-6.8	0.7	SG-203-A07-1	1.1
-6.5	1	SG-203-A02-1	1.4
		SG-203-D02-1	1.1
-6.5	1	SG-203-A02-2	8.0
-7.9	0.7	SG-203-B11-1	5.0
-6.1	0.9	SG-203-E15-1	1.7
-6.2	0.8	SG-203-C17-1	1.9
-9.6	0.9	SG-203-B18-1	1.0
-7.9	0.7	SG-203-B11-2	1.7
-8	0.8	SG-203-A12-1	5.5
-8.2	0.8	SG-203-F08-2	6.4
-9.6	0.9		
-6.1	1.2		
-8	0.8		
-6.8	0.7		
-7.1	0.8		
-6.7	0.9		
-6.1	0.9		
-6.6	0.8		
-7.9	0.7		
-8	0.8		
-7.1	0.8		
-7	0.6		
-7.6	1		
-6.8	0.1		

-8.2	0.8		
-6.5	1		
-6.5	0.7		
-6.1	0.9	SG-203-E15-2	2.0
-7	0.6	SG-203-A06-1	11.3
		SG-203-D07-2	1.7
-8.2	0.8	SG-203-F08-1	1.8
-6.5	0.7		
-8.2	0.8		

		SG-265-A02-TE-2	2.2
		SG-265-A06-TE-2	9.7

-0.8	1.4		
-0.8	1.4		
-0.6	0.7	SG-265-A08-TE-2	6.1
-0.6	0.7		
0.7	1	SG-265-A14-TE-1	3.8
0.7	1		
1.5	0.8	SG-265-A17-TE-1	14.5
1.5	0.8	SG-265-A17-TE-2	2.1

1.4	0.8	SG-265-A04-TE-2	90.0
1.3	0.7	SG-265-A06-TE-1	54.9
0.2	1	SG-265-A07-TE-1	36.6
-0.6	0.7	SG-265-A08-TE-1	33.0
0.7	1	SG-265-A14-TE-2	32.3
1.5	0.9	SG-265-A02-TE-1	2.1
1.4	0.8	SG-265-A04-TE-1	10.9

-12.3	1.2	SG-127-B01-1	1.7
-12.8	1.2	SG-127-B16-2	1.2
-14.5	0.9	SG-127-D04-2	1.0
-10.3	1.1	SG-127-E01-2	1.2

-10.3	1.1	SG-127-E01-1	2.4
-14.5	0.9	SG-127-D04-1	1.1
-13.9	1.4	SG-127-D06-1	1.7
-11.5	0.8	SG-127-A16-2	2.2
-12.4	0.9	SG-127-A01-1	1.8
-13.9	1.4	SG-127-D06-2	6.2
-13.3	0.9	SG-127-B11-1	3.8
-14.5	0.9		
-12.3	1.2		
-13.9	1.4		

-12.8	1.2	SG-127-B16-1	14.9
-12.3	1.2	SG-127-B01-2	24.5
-13.3	0.9	SG-127-B11-2	16.4
-11.5	0.8	SG-127-A16-1	2.1

31P	40Ca	56Fe	89Y	139La	140Ce	141Pr
192.5	3.3	1.5	546.5	0.0	2.5	0.0
252.5	3.0	2.7	1128.7	0.0	7.3	0.1
227.1	6.0	2.9	1248.3	0.0	5.4	0.0
268.9	2.5	3.1	1186.9	0.0	7.7	0.1
300.5	3.3	3.4	1794.8	0.0	8.2	0.1
87.5	2.3	4.1	309.1	0.0	3.1	0.0
277.4	2.2	4.3	1008.3	0.0	3.7	0.1
177.5	2.8	4.3	869.8	0.0	7.3	0.0
197.7	2.5	4.4	995.5	0.0	6.4	0.0
217.6	2.6	4.5	950.1	0.0	7.0	0.0
217.8	3.3	4.7	1179.5	0.4	7.3	0.4
223.4	3.3	5.0	892.4	0.0	5.2	0.1
203.2	2.7	5.0	1155.5	0.0	4.5	0.0
294.6	7.4	5.8	1808.3	0.0	9.5	0.1
294.1	2.7	6.0	1677.9	0.0	8.3	0.1
198.7	4.1	8.2	998.2	0.0	7.8	0.0
191.7	4.5	8.4	1640.9	0.0	6.7	0.1
368.4	4.4	9.8	1730.5	0.0	8.5	0.1
118.3	11.8	10.9	647.0	2.3	16.8	1.4
189.1	3.3	11.2	1965.5	0.0	8.5	0.1
126.4	6.2	14.8	602.3	0.0	6.6	0.0
79.5	3.7	16.5	324.5	0.0	3.9	0.0
176.1	1.9	18.8	1681.8	0.0	4.9	0.1

393.5	10.2	41.1	2528.2	1.8	31.4	1.2
249.3	9.7	10.8	1953.6	0.0	10.1	0.1
178.2	2.2	6.2	1737.2	0.0	7.6	0.1

97.6	3.7	1.9	606.0	0.0	4.2	0.0
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154.5	1.0	1.6	527.2	0.0	24.6	0.1
160.3	1.0	1.7	476.2	0.0	24.5	0.1
170.1	1.1	1.7	457.6	0.0	29.6	0.1
166.4	1.7	1.8	824.7	0.0	26.8	0.3
203.9	1.3	2.1	584.8	0.0	23.0	0.2
166.6	2.2	2.2	518.7	0.0	25.5	0.1
181.4	1.1	2.4	1073.9	0.0	24.7	0.6
183.1	3.2	2.6	502.6	0.4	28.2	0.4
136.1	2.1	2.7	347.0	0.0	20.6	0.1
162.1	1.0	2.9	464.7	0.0	27.6	0.1
131.3	1.6	3.1	315.2	0.0	21.6	0.1
159.6	1.3	3.1	441.1	0.0	23.5	0.1
149.4	1.2	3.4	829.9	0.0	25.9	0.6
169.4	1.8	3.4	452.2	0.0	25.5	0.1
129.6	1.6	3.5	361.2	0.0	29.0	0.1
168.7	1.5	3.5	1043.4	0.0	31.8	0.6
164.7	1.5	3.6	599.0	0.0	28.2	0.1
164.2	1.7	3.8	471.5	0.0	27.5	0.1
169.6	1.5	3.8	508.8	0.0	26.9	0.2
164.6	1.3	4.1	543.7	0.0	30.3	0.1
148.7	2.3	4.7	391.6	0.0	24.5	0.1
145.5	2.3	5.5	446.1	0.0	32.5	0.1
147.3	2.0	6.3	448.6	0.0	33.9	0.1

7.0	6.7	25.2	14.3	2.5	5.4	1.3
172.8	76.4	3.8	510.3	179.6	252.8	21.8
222.8	3.3	4.7	751.9	0.1	24.7	0.3
8.3	19.6	46.7	46.5	8.1	17.0	4.0

133.4	1.2	3.4	594.5	0.0	6.4	0.0
63.5	11.6	3.4	151.9	0.0	2.4	0.0
111.2	3.0	4.8	341.1	0.0	3.1	0.1
179.9	9.5	6.8	612.0	0.2	6.9	0.2
167.6	3.9	11.6	812.3	0.2	9.5	0.4
137.9	1.3	14.5	627.9	0.0	4.7	0.0

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87.7	10.2	21.6	222.9	0.1	4.5	0.1
61.4	157.5	24.8	183.9	3.0	13.0	1.7
167.1	8.0	38.9	833.2	0.3	10.6	0.5
202.2	44.7	47.0	689.3	3.3	33.8	5.7
115.6	62.6	901.0	438.8	7.4	55.5	9.3
69.6	36.9	30.1	280.9	0.0	3.8	0.0
85.8	11.2	7.6	73.0	0.0	1.8	0.0
72.9	1.1	2.7	260.3	0.0	3.0	0.0

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25.5	1.9	1.2	61.6	0.0	0.1	0.1
70.1	1.2	1.6	448.2	0.0	0.1	0.1
47.1	0.5	17.6	306.2	0.0	3.8	0.1

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70.6	12.1	21.0	301.5	1.0	10.0	0.5
105.9	1.2	25.8	546.9	0.0	11.4	0.1
117.3	1.1	30.2	691.0	0.0	15.4	0.1
135.0	0.9	51.5	1355.7	0.0	14.2	0.1
67.1	5.2	288.3	288.8	0.2	5.0	0.2
39.0	9.7	637.7	356.9	0.0	1.9	0.1

42.4	48.3	1208.8	464.9	0.0	7.3	0.2
119.1	77.7	32.3	787.0	2.2	24.6	3.9
121.1	2.5	35.4	1078.4	0.0	16.7	0.1
222.3	50.5	24.1	917.2	1.7	16.0	0.6
135.7	110.7	59.4	1239.2	8.9	43.5	4.2
60.9	8.5	12.5	228.9	0.7	6.9	0.5
120.8	2.0	25.4	789.7	0.0	10.5	0.1
131.9	1.4	34.7	654.1	0.0	12.1	0.1

157.9	9.5	0.8	624.6	0.0	11.9	0.1
113.6	0.2	1.6	512.8	0.0	11.4	0.1
130.3	0.4	1.8	615.4	0.0	9.8	0.1
112.7	1.1	2.0	541.3	0.0	11.8	0.1
140.6	0.6	2.1	666.6	0.1	13.6	0.1
88.0	0.5	2.1	332.7	0.0	7.3	0.1
150.6	3.4	2.3	594.1	0.1	9.2	0.1
159.9	1.4	2.8	1401.2	0.0	14.0	0.3
147.7	0.4	3.0	435.4	0.1	7.4	0.1
143.1	0.5	3.1	712.6	0.0	13.6	0.1
103.1	0.5	3.3	603.0	0.1	19.6	0.1
89.3	1.7	3.6	309.0	0.1	9.1	0.1
169.3	1.4	3.8	689.1	0.1	10.0	0.1
105.4	1.9	3.9	580.4	0.5	14.4	0.4
174.6	0.4	3.9	1338.4	0.0	15.5	0.3
162.4	2.8	4.5	770.0	0.0	15.2	0.1
95.3	3.6	5.6	548.6	0.0	8.0	0.1
113.3	4.9	7.1	494.7	1.0	11.9	0.2

126.1	5.4	158.1	500.6	0.2	10.1	0.2
193.6	372.0	60.5	638.1	6.8	28.2	2.2
90.8	1.9	12.3	802.1	0.0	9.9	0.1
164.0	0.2	3.2	851.5	0.2	18.2	0.2

92.9	14.0	2.4	211.1	0.0	2.8	0.1
159.8	1.1	5.7	471.0	0.0	7.1	0.1
118.9	1.2	3.7	315.9	0.0	3.9	0.1
140.9	2.9	5.9	495.1	0.0	7.7	0.1
61.1	1.3	10.3	192.4	0.0	2.8	0.1
63.3	0.7	2.3	174.5	0.0	2.6	0.0

315.5	10.3	171.5	973.5	0.5	27.0	0.7
193.0	26.8	1079.7	3545.4	0.2	22.7	0.2
84.5	1.9	4.6	84.6	0.0	2.5	0.0
98.2	1.1	5.9	120.2	0.0	3.4	0.0
95.6	6.9	4.1	137.4	0.4	5.9	0.3
70.5	23.3	1.8	175.2	0.0	2.3	0.1
221.3	7.2	15.3	511.8	0.2	14.5	0.8

68.4	0.3	1.1	282.2	0.0	5.9	0.1
104.8	0.1	1.1	374.1	0.3	31.5	5.9
92.5	0.3	1.8	352.0	0.0	6.3	0.1
63.5	0.2	1.9	176.1	0.0	2.4	0.1

67.5	0.3	1.9	191.5	0.0	3.1	0.1
73.5	0.2	3.5	301.4	0.0	7.0	0.1
185.2	0.2	4.9	697.4	0.0	13.1	0.2
245.0	0.3	5.0	888.3	0.0	11.9	0.2
159.5	0.4	5.2	1872.1	0.0	21.0	0.6
105.2	2.2	7.4	369.8	1.8	16.9	1.3
532.6	0.4	10.4	1584.5	0.0	7.9	0.1

98.7	12.1	53.0	162.6	0.7	14.6	0.7
212.2	28.6	32.3	1264.3	2.1	33.4	2.2
416.7	62.3	32.8	1326.8	0.1	7.6	0.1
321.3	0.6	6.9	1450.2	0.0	20.4	0.2

145Nd	147Sm	153Eu	157Gd	159Tb	163Dy	165Ho
0.4	1.2	0.2	6.8	3.0	38.8	16.5
1.2	3.3	0.5	16.6	6.9	86.8	36.0
0.8	2.5	0.5	12.1	5.0	64.1	30.4
1.2	3.7	0.5	18.0	7.3	92.8	38.3
1.3	4.0	0.8	21.7	9.2	123.0	55.1
0.2	0.5	0.1	3.1	1.4	19.3	9.2
1.1	3.0	0.6	15.4	6.2	79.1	32.7
0.6	2.2	0.3	12.3	5.0	67.4	28.8
0.8	2.5	0.3	13.5	5.9	75.8	31.8
0.8	2.6	0.4	13.6	5.9	74.9	30.9
2.7	4.0	0.6	17.0	6.9	92.2	37.9
1.0	2.6	0.5	12.5	5.2	65.7	27.7
1.0	3.1	0.4	16.1	6.8	83.4	35.7
1.5	4.2	0.7	21.8	9.5	126.7	56.5
1.3	4.0	0.7	22.2	9.2	122.8	53.9
0.8	2.5	0.3	12.6	5.4	66.5	29.4
1.8	6.0	0.9	29.4	11.3	137.2	53.4
1.6	4.4	0.7	21.3	9.3	121.0	52.8
7.9	5.3	0.4	10.7	3.8	46.7	20.0
2.5	8.2	1.3	37.6	14.3	169.2	66.1
0.4	1.2	0.2	5.9	2.7	37.4	17.4
0.2	0.4	0.1	2.7	1.3	19.2	9.0
2.9	7.4	1.3	31.3	11.9	145.1	56.1

8.9	10.4	1.9	43.4	17.5	214.4	84.7
2.3	7.2	1.0	35.9	13.8	170.6	65.2
2.4	6.7	0.9	30.3	11.6	138.2	54.7

0.4	1.4	0.2	7.9	3.3	43.8	18.1
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2.1	4.5	1.0	15.1	4.6	49.1	17.1
1.7	3.9	0.9	13.5	4.1	43.5	14.9
2.1	4.7	1.1	13.7	3.9	42.6	14.6
5.5	11.1	2.0	30.9	8.7	86.1	27.4
3.1	6.0	1.3	18.5	5.4	57.4	19.3
2.5	5.9	1.3	19.2	5.4	54.5	17.6
10.2	16.4	3.1	40.9	11.3	114.7	37.5
4.4	6.8	1.5	16.7	4.7	47.3	15.8
1.3	2.7	0.7	9.1	2.9	31.3	11.2
2.2	4.7	1.0	15.2	4.3	43.6	15.0
1.2	2.8	0.6	8.9	2.7	29.1	10.3
1.3	3.1	0.7	11.2	3.6	39.9	14.0
9.6	15.9	2.9	38.4	10.2	94.8	30.5
2.0	4.6	1.1	13.7	4.1	43.8	14.8
1.3	2.7	0.6	8.9	3.0	31.3	11.0
10.1	18.3	3.6	40.0	10.8	105.0	33.7
2.2	5.2	1.0	15.4	4.9	53.2	18.4
1.6	3.8	0.8	12.1	3.6	40.7	14.7
2.7	5.7	1.2	17.3	4.9	49.8	16.3
2.1	5.1	1.1	16.4	5.1	54.0	18.0
1.6	3.6	0.9	11.2	3.3	34.9	12.2
1.5	3.4	0.7	12.1	3.7	41.4	14.3
1.6	4.0	0.8	12.1	3.5	40.5	14.0

8.3	3.5	0.2	2.4	0.2	1.2	0.4
74.1	8.6	1.3	16.4	4.7	48.2	16.4
5.4	8.7	1.8	22.0	6.4	67.0	22.0
24.7	10.4	0.5	6.7	0.7	4.2	1.1

0.8	2.9	0.8	10.4	3.6	48.7	18.6
0.4	0.7	0.2	3.0	1.1	12.3	4.4
1.0	2.8	1.0	9.5	2.8	30.1	10.4
2.6	4.7	1.2	14.1	4.6	51.6	19.0
3.7	5.6	1.1	17.2	5.6	66.4	22.4
0.4	1.5	0.3	8.8	3.7	50.0	19.1

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1.1	2.4	0.8	8.9	2.4	23.7	7.3
12.6	8.5	1.4	7.7	1.3	13.6	5.4
4.6	6.7	1.4	18.7	6.2	70.3	24.3
48.9	17.2	1.8	22.9	5.9	64.1	22.8
72.7	34.2	6.8	34.4	5.3	41.8	13.4
0.4	1.3	0.3	6.4	2.2	25.5	9.4
0.4	0.6	0.2	1.6	0.5	5.0	1.8
0.4	1.1	0.3	5.6	1.9	21.2	7.2

0.4	0.1	0.0	0.2	0.1	2.2	1.5
0.4	0.1	0.1	0.7	0.7	15.1	11.0
0.8	1.0	0.4	4.6	1.7	21.9	9.0

3.0	1.6	0.2	4.4	1.6	19.7	8.4
0.9	1.8	0.4	7.8	3.1	38.1	15.8
1.1	2.5	0.5	10.3	4.0	49.5	20.2
2.0	6.1	1.1	26.6	9.5	111.3	41.8
1.8	1.2	0.2	4.2	1.6	22.1	9.2
0.6	0.7	0.4	3.6	1.5	19.8	8.5

2.3	3.4	1.6	10.5	3.2	35.1	13.1
37.4	22.9	1.4	22.1	5.3	53.5	20.6
2.5	6.1	1.4	22.3	7.8	89.2	33.1
3.9	2.7	2.8	11.7	4.9	62.6	27.3
29.0	13.3	4.5	29.3	9.1	101.5	38.5
3.4	1.9	0.4	4.5	1.4	16.1	6.2
1.0	2.2	0.4	10.9	4.4	54.6	23.1
0.9	2.0	0.4	9.3	3.7	47.1	19.1

1.4	2.9	0.3	11.6	4.2	49.8	19.1
1.1	2.2	0.1	8.8	3.4	42.1	16.4
1.6	3.4	0.2	13.6	4.9	56.6	21.2
1.2	2.3	0.1	9.8	3.7	44.1	17.5
1.4	3.0	0.2	11.9	4.4	54.2	21.3
0.9	1.3	0.1	5.3	2.0	23.7	9.8
1.4	2.7	0.3	10.2	3.8	44.2	18.0
4.8	10.1	0.8	35.6	12.0	128.3	46.3
1.2	1.9	0.3	7.5	2.9	32.3	12.9
1.4	2.9	0.2	12.0	4.4	51.8	20.8
1.2	2.4	0.1	10.9	4.0	50.7	20.6
0.9	1.2	0.1	5.3	1.9	24.3	10.0
2.3	4.1	0.3	14.6	5.3	61.5	22.9
3.2	4.0	0.3	12.8	4.3	50.0	19.2
4.8	9.7	0.9	33.7	11.1	120.5	43.6
1.9	3.9	0.2	14.0	5.1	56.9	22.7
1.3	2.6	0.2	10.9	3.9	45.5	18.3
1.5	2.0	0.2	7.6	2.9	37.1	15.5

1.5	2.5	0.2	9.4	3.5	41.0	16.0
11.3	5.3	0.3	13.4	4.5	52.3	18.4
1.1	2.2	0.1	10.4	4.2	58.3	24.8
1.9	3.8	0.1	15.2	5.5	67.2	26.4

0.7	1.2	0.4	3.7	1.2	12.8	5.4
1.3	2.2	0.8	9.0	3.1	36.7	14.3
0.8	1.3	0.5	4.9	1.7	21.2	8.7
1.6	2.5	0.9	10.1	3.5	40.6	15.6
0.7	1.2	0.5	4.9	1.6	17.3	5.9
0.6	1.2	0.4	5.0	1.5	16.7	5.9

11.5	28.8	11.4	88.3	19.8	139.1	31.1
2.1	6.9	2.4	56.9	24.9	326.3	126.3
0.4	0.5	0.2	1.8	0.6	7.3	2.8
0.6	0.7	0.2	2.7	0.9	9.8	3.7
2.1	1.5	0.5	3.6	1.1	11.3	4.2
0.6	0.8	0.3	3.1	1.1	13.2	5.2
12.8	21.6	7.6	48.8	10.7	70.3	16.1

1.1	2.0	0.5	7.9	2.5	26.5	9.0
56.4	28.1	1.4	22.1	4.4	32.4	10.4
1.1	1.9	0.6	7.4	2.5	25.3	9.3
0.8	1.6	0.4	6.2	1.9	15.0	4.5

1.5	3.0	0.6	10.5	2.8	23.3	5.9
1.0	2.0	0.5	8.3	2.7	28.9	9.8
2.6	5.1	1.2	17.4	5.7	61.1	22.1
2.3	5.3	1.3	21.3	7.2	79.2	27.5
9.4	19.1	4.0	65.5	20.5	214.1	67.3
8.4	6.3	0.7	11.3	3.3	33.8	11.7
1.1	3.9	0.8	21.3	9.4	114.2	43.2

4.9	4.5	0.6	8.7	2.3	17.8	4.5
18.4	19.5	2.0	44.3	11.5	116.2	40.7
1.4	4.1	0.8	22.2	9.1	109.9	41.0
3.5	8.2	2.2	31.7	10.7	112.9	41.6

166Er

169Tm

172Yb

175Lu

80.4	19.2	184.2	37.8
165.1	36.9	349.2	70.2
160.2	38.6	388.3	83.6
172.8	38.4	363.1	72.7
275.5	63.9	619.9	130.3
47.6	11.9	122.0	26.0
152.7	34.4	323.8	65.3
131.4	29.6	285.2	56.9
149.1	33.5	319.2	64.4
142.5	31.9	305.0	60.4
183.0	42.3	415.6	85.7
129.6	29.8	286.3	59.4
171.2	38.3	357.2	73.1
275.9	64.1	628.9	130.1
256.4	58.0	552.9	111.6
139.7	32.9	321.5	65.8
234.7	50.1	455.2	89.0
259.8	59.4	570.2	118.4
100.7	25.9	277.9	60.0
283.3	59.5	532.5	102.9
91.7	23.9	260.3	58.7
51.5	14.4	171.9	41.2
241.5	51.0	463.1	89.0

375.2	79.8	711.7	135.6
280.2	59.6	543.1	104.0
241.7	53.7	486.4	97.0

84.4	20.3	199.3	39.5
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69.1	14.6	133.3	25.6
58.7	12.4	113.0	22.7
59.0	12.2	107.8	20.5
106.4	21.6	193.8	36.2
77.2	16.5	151.4	29.1
69.0	14.5	131.6	25.7
145.4	28.5	253.2	47.4
63.6	13.7	125.7	24.4
45.2	10.0	91.8	17.9
60.1	12.7	117.5	22.5
41.9	9.1	85.5	16.5
58.0	12.5	112.4	22.3
114.7	22.7	200.0	37.4
59.6	12.8	116.4	22.2
47.6	10.8	104.9	20.6
130.7	26.6	228.8	42.9
74.0	16.5	145.1	27.9
59.8	12.8	113.8	22.6
64.1	13.5	120.6	23.6
71.7	15.2	141.4	27.1
48.7	10.7	97.0	18.4
60.1	13.3	123.8	24.5
58.6	13.0	119.7	23.3

2.0	0.7	9.9	3.6
67.3	14.8	138.5	27.9
84.3	18.6	159.3	31.8
5.5	1.6	22.8	8.1

78.3	18.1	160.9	30.0
18.6	4.4	41.1	8.1
44.5	9.8	94.2	19.2
79.0	17.4	160.6	30.8
94.2	20.1	172.1	33.6
85.5	19.7	183.4	35.5

28.1	5.8	51.5	9.8
28.8	8.6	104.6	24.1
99.9	23.0	195.5	36.5
90.7	19.3	172.9	32.7
53.3	11.9	116.4	23.6
39.9	9.1	84.8	16.3
8.0	2.0	18.8	4.3
30.5	6.8	68.9	14.2

10.6	3.9	52.1	13.6
89.9	32.9	442.5	115.4
44.7	12.1	140.7	33.5

42.8	10.9	119.0	27.1
77.1	19.0	202.0	43.5
96.2	23.6	242.2	51.4
191.5	44.5	444.3	93.0
46.2	12.0	131.5	29.5
48.8	13.8	163.3	41.9

63.2	15.8	182.7	42.0
97.2	25.6	261.9	58.4
152.2	35.6	362.2	76.7
135.0	33.8	361.2	78.2
173.3	39.9	400.9	82.4
29.9	8.4	91.5	21.3
116.5	29.6	316.4	74.3
95.8	24.1	252.8	54.8

86.7	19.0	175.1	34.1
72.3	16.3	147.6	28.9
90.4	19.1	170.6	31.7
79.4	17.5	162.6	31.4
95.6	21.2	195.6	37.2
45.9	10.5	95.1	17.8
79.9	18.0	163.4	31.9
191.0	39.0	340.5	62.5
56.9	13.4	122.8	24.9
98.3	21.8	196.5	38.4
93.9	21.4	202.9	39.0
46.3	10.7	105.0	20.2
96.9	21.0	189.0	35.2
85.0	18.4	169.9	32.0
183.3	38.0	329.9	61.3
101.3	23.0	211.4	39.6
81.0	17.5	157.0	30.1
72.4	16.3	153.5	30.0

70.0	15.1	136.5	25.4
84.6	20.0	175.7	35.0
122.6	30.1	299.6	60.5
118.6	25.9	235.5	44.2

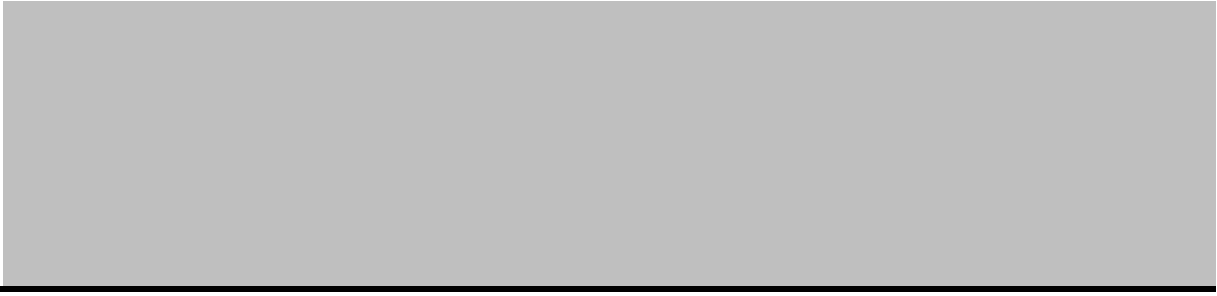
27.2	6.6	66.4	14.7
65.1	15.0	150.9	31.7
43.3	10.3	93.7	20.4
68.9	15.5	153.8	31.7
24.4	5.4	52.5	11.2
25.2	5.5	53.0	11.5

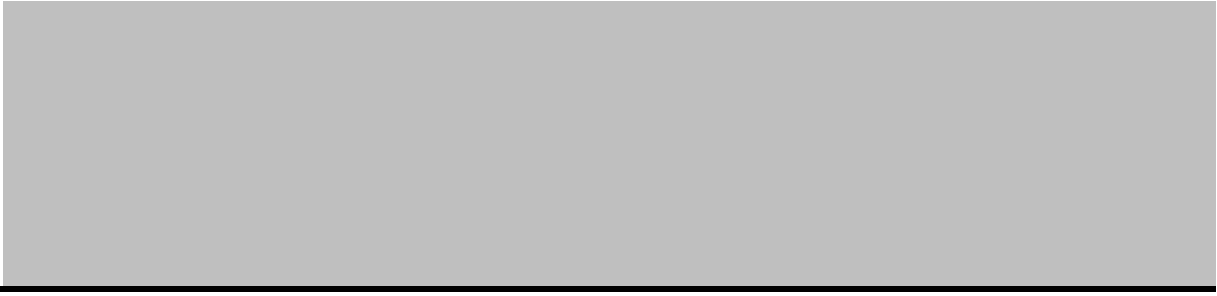
84.5	11.9	75.4	10.5
530.5	110.5	973.4	169.8
12.4	2.9	30.4	6.6
16.5	3.9	39.3	8.4
18.6	4.3	42.4	9.3
24.8	5.9	61.0	13.4
46.1	6.9	45.4	6.3

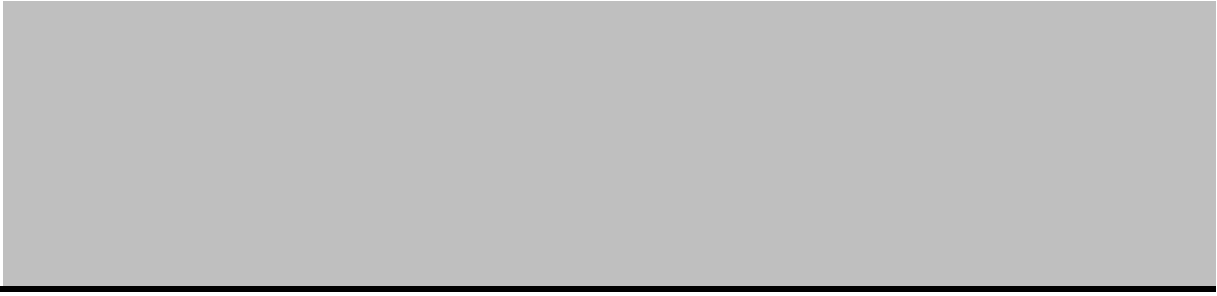
36.0	7.2	63.6	11.6
43.4	8.8	76.0	14.8
38.5	7.9	68.8	12.8
14.9	2.7	18.9	3.3

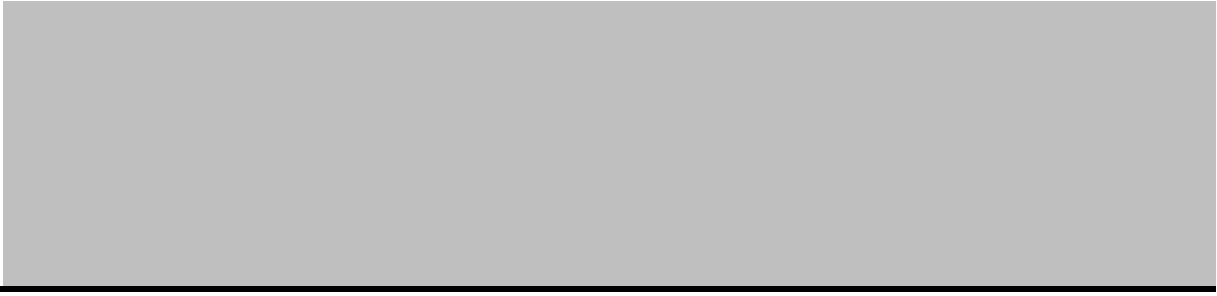
18.3	3.2	25.1	4.0
38.3	7.7	68.1	12.2
92.4	20.0	181.3	34.9
112.7	22.8	198.3	36.3
245.1	45.1	364.8	60.6
47.0	10.0	88.4	16.5
188.4	39.2	321.4	58.7

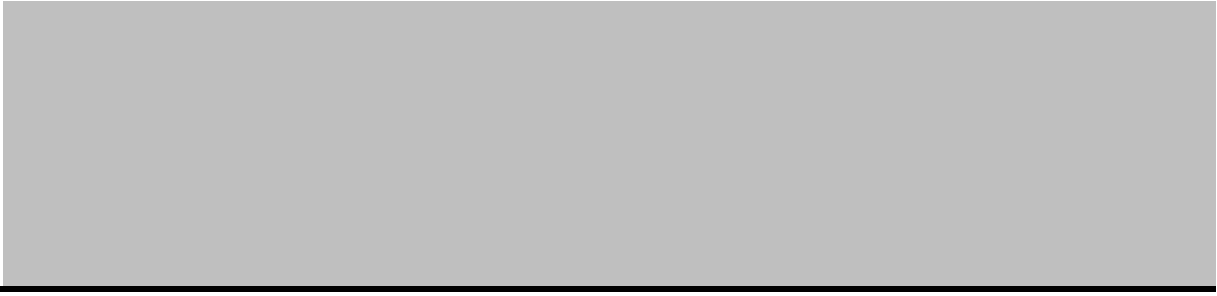
14.2	2.7	21.3	3.8
161.9	32.3	275.5	49.9
174.1	37.0	328.5	60.5
164.9	34.7	290.5	48.2

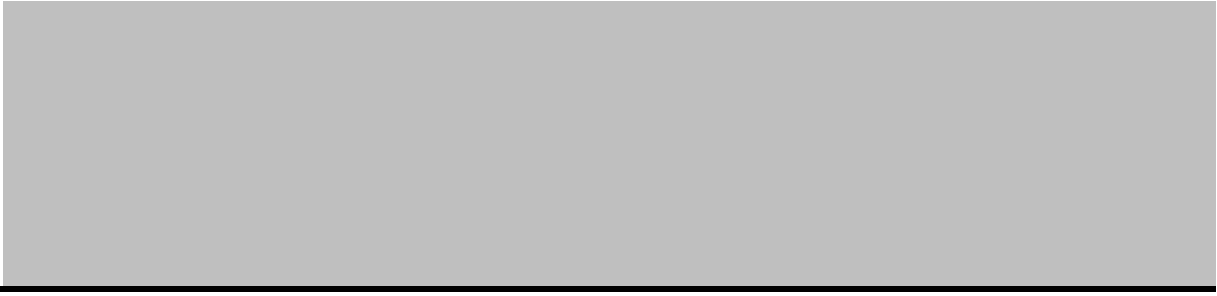


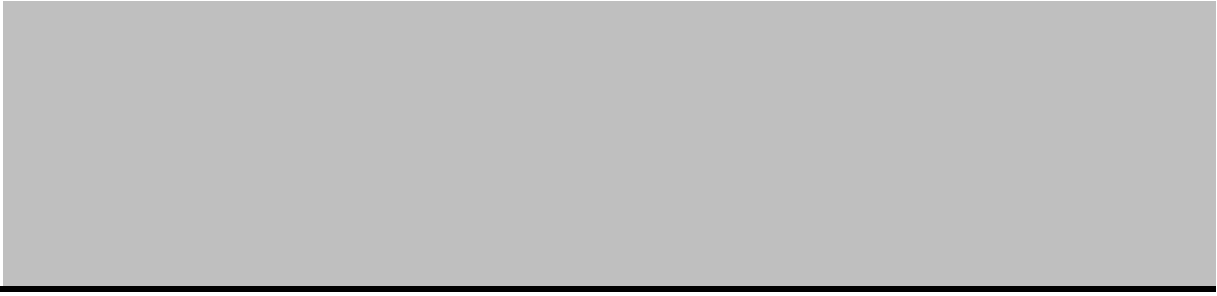


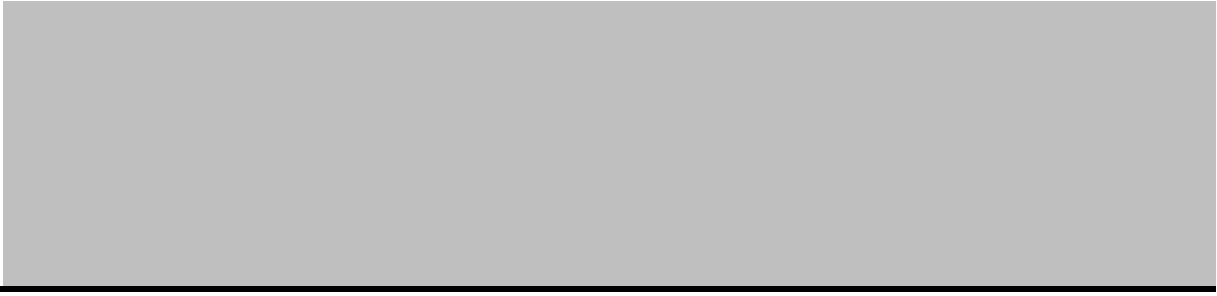


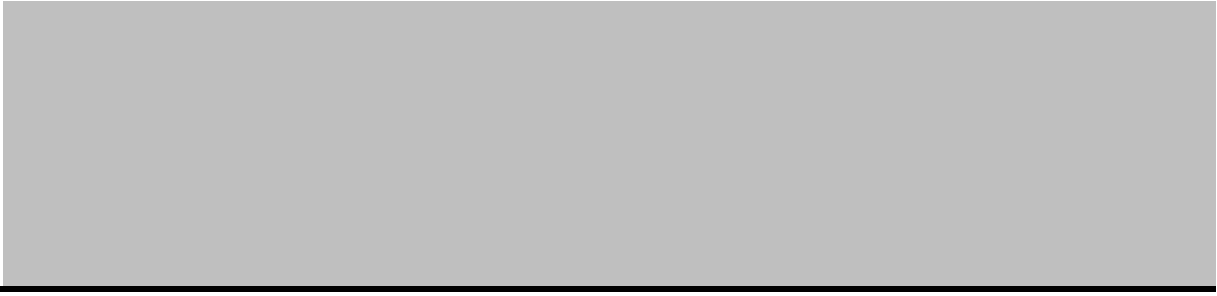


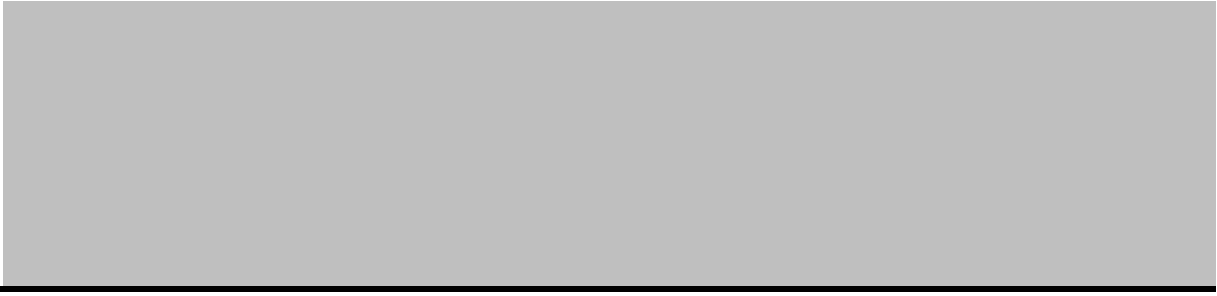


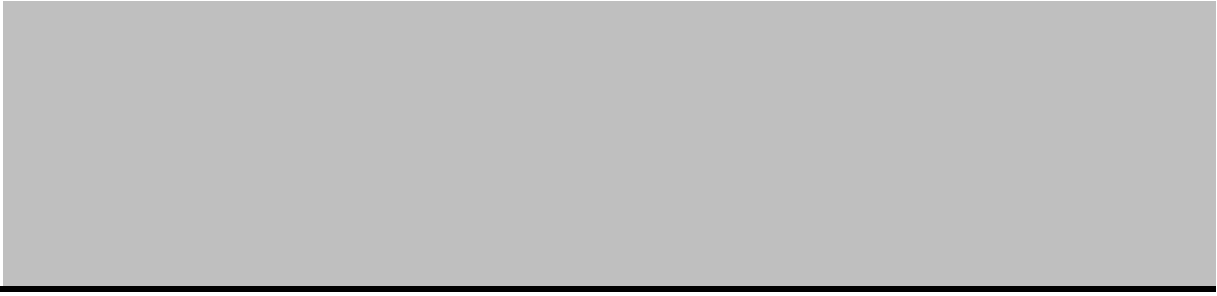


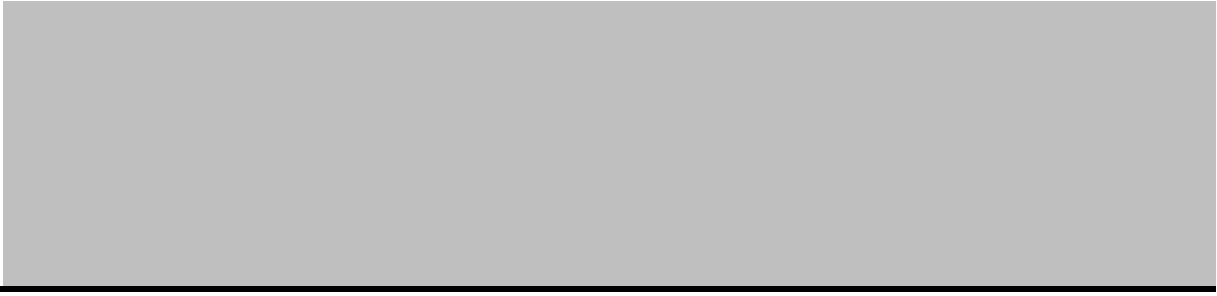


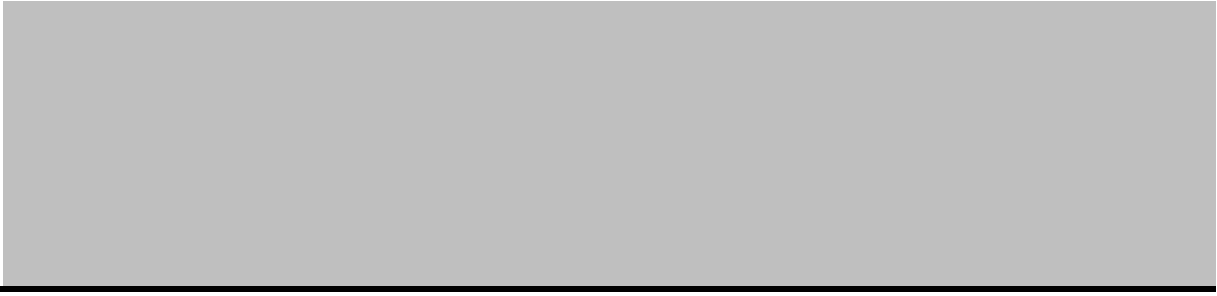


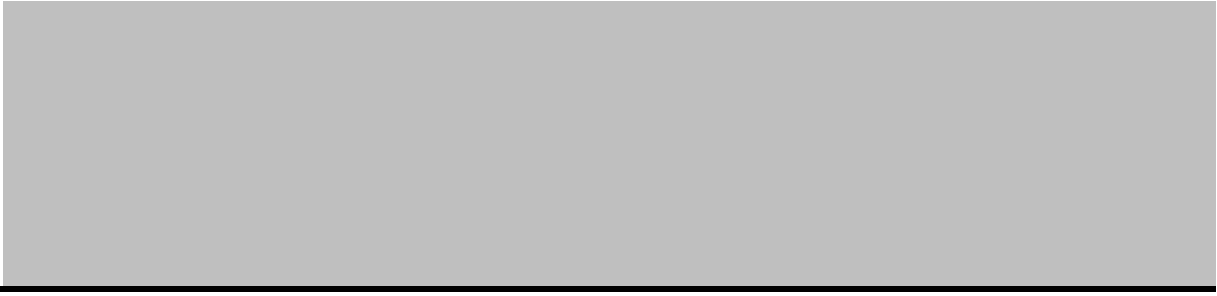


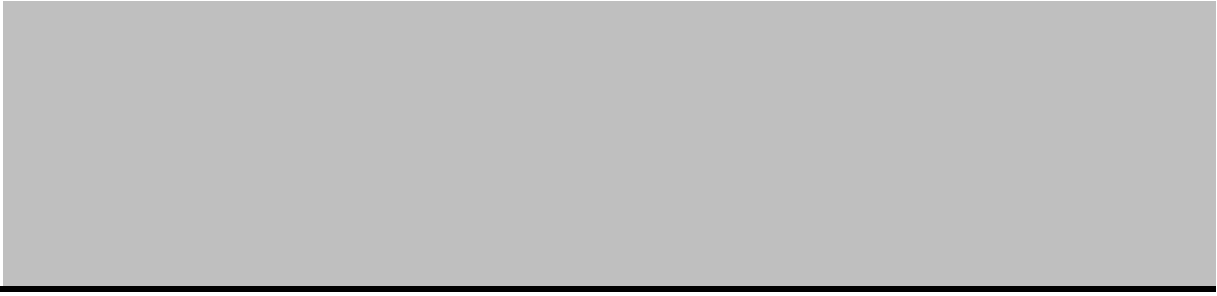


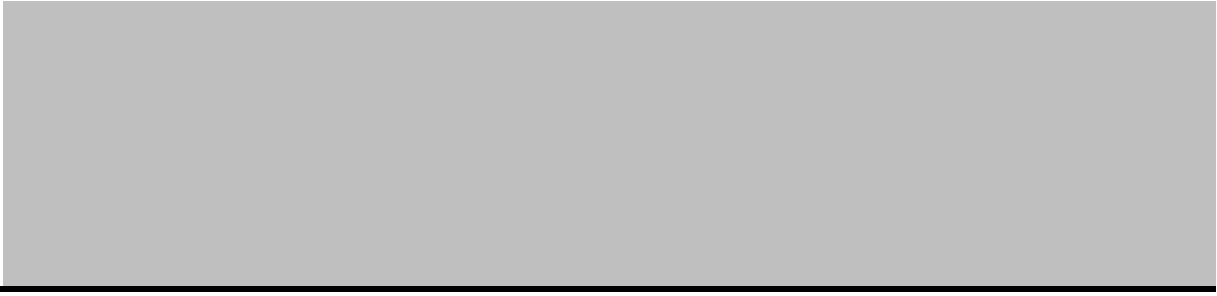


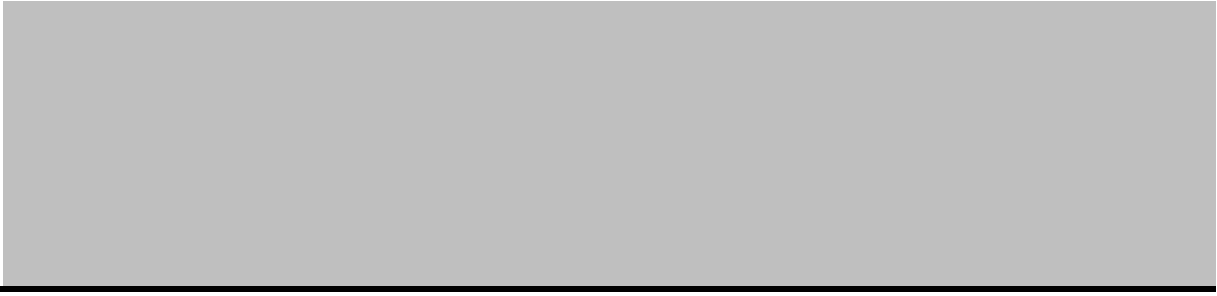


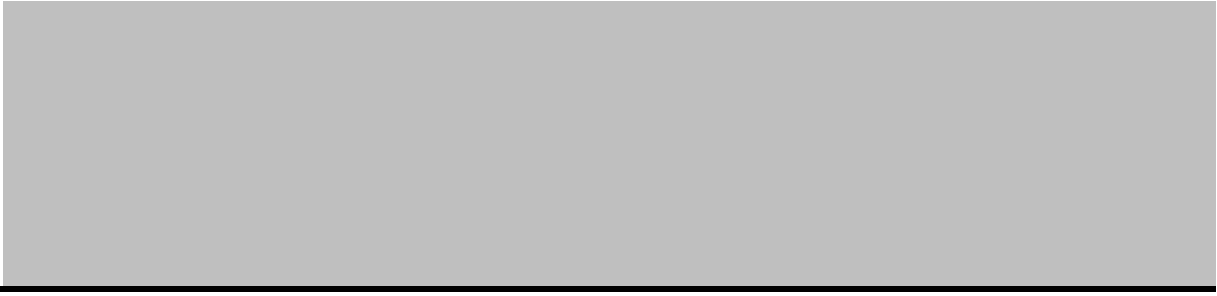


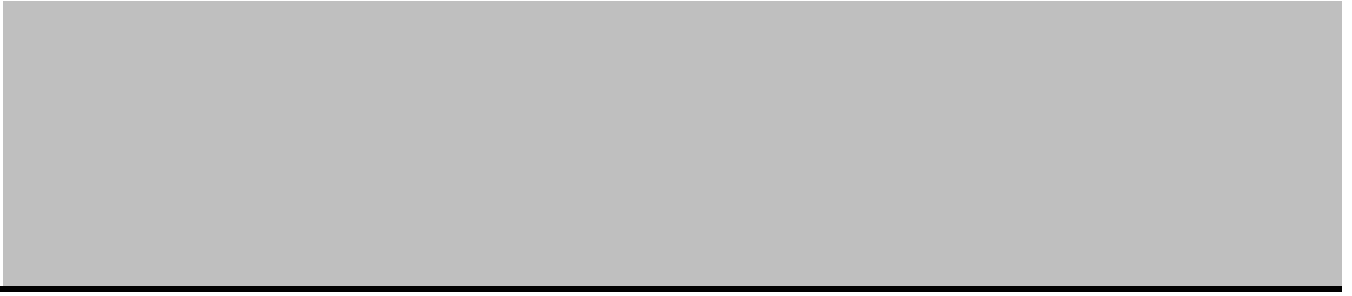


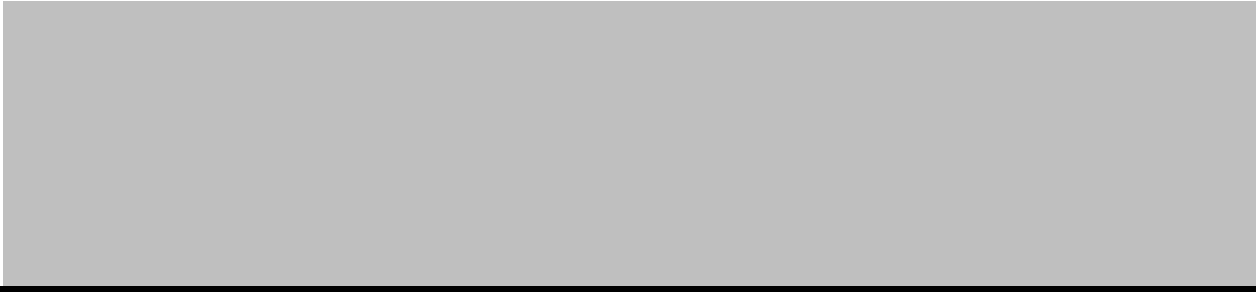


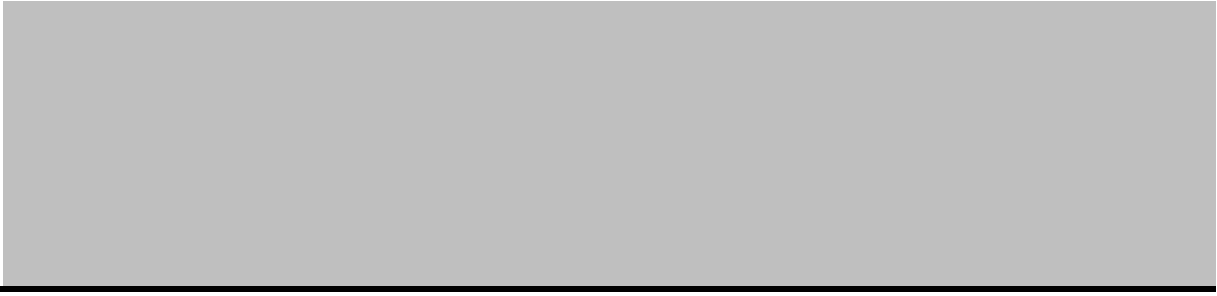


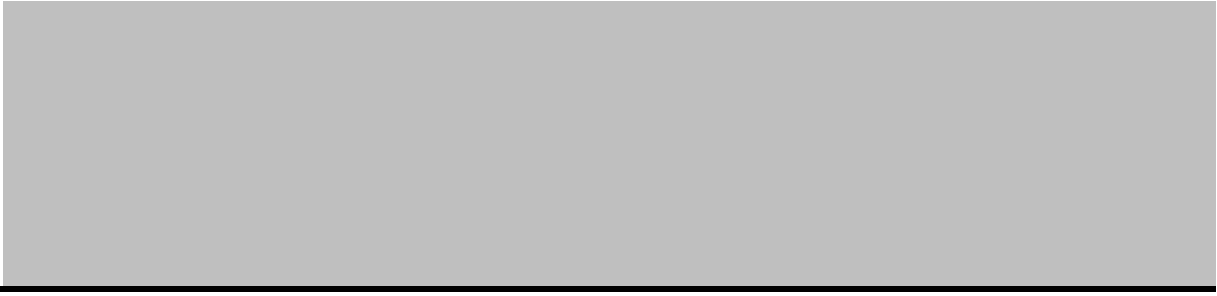


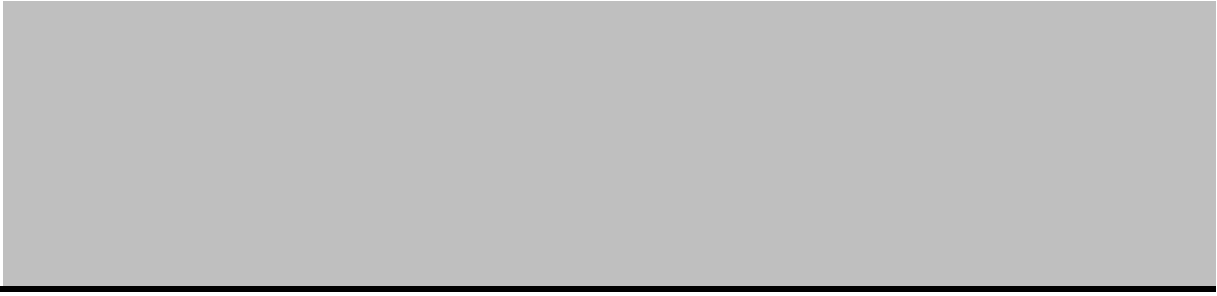


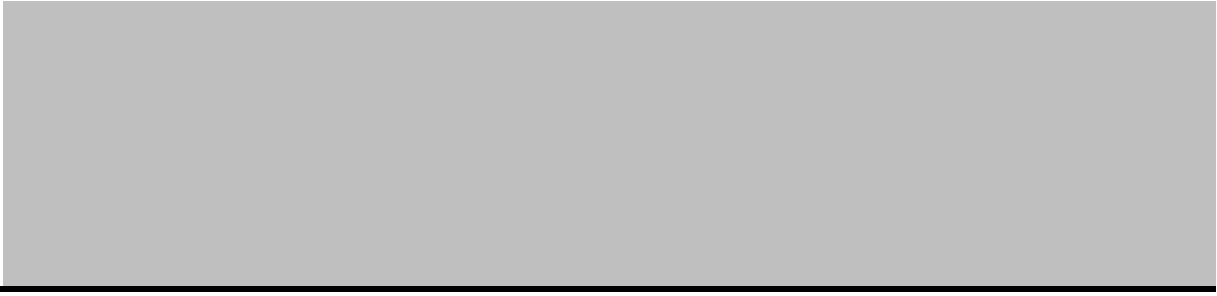


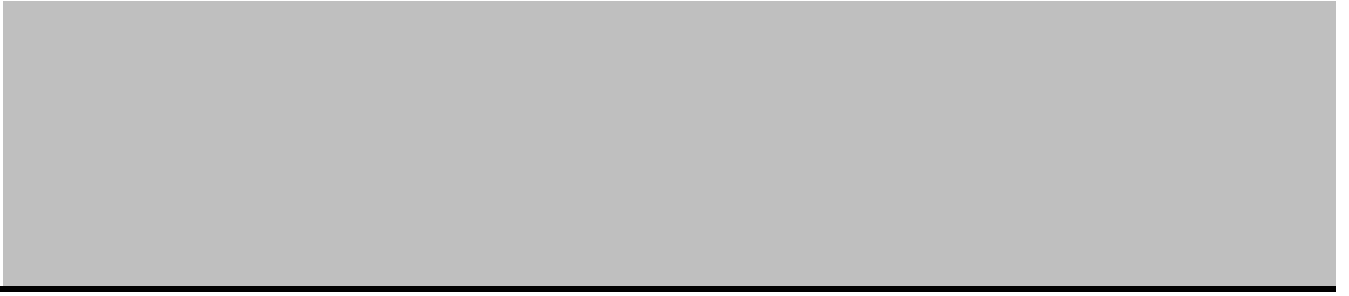


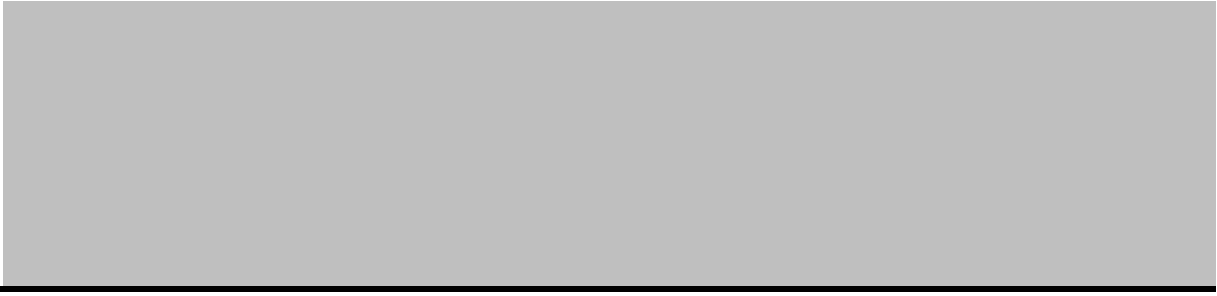


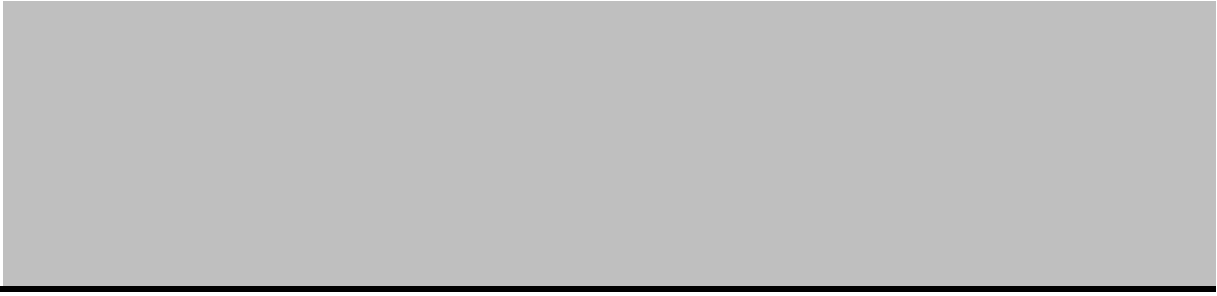


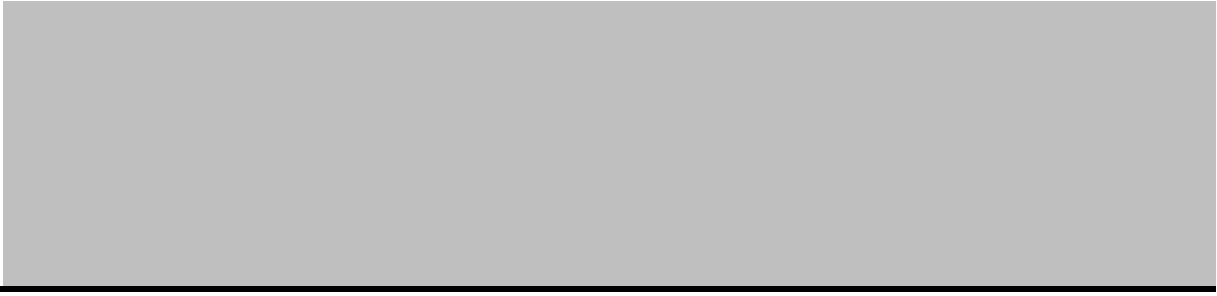


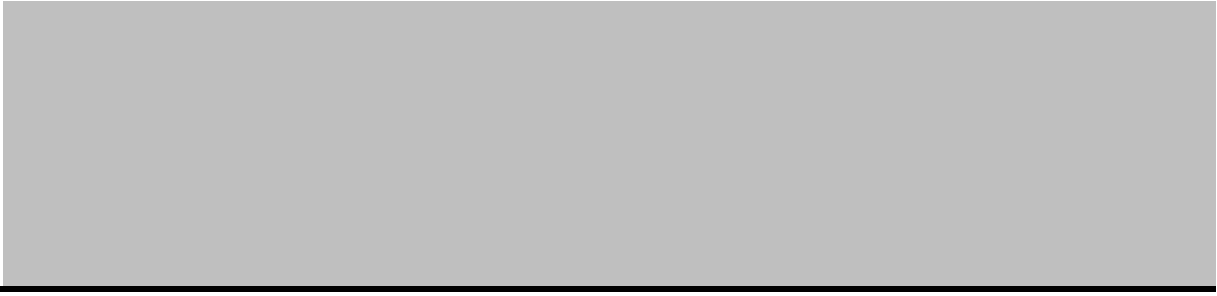


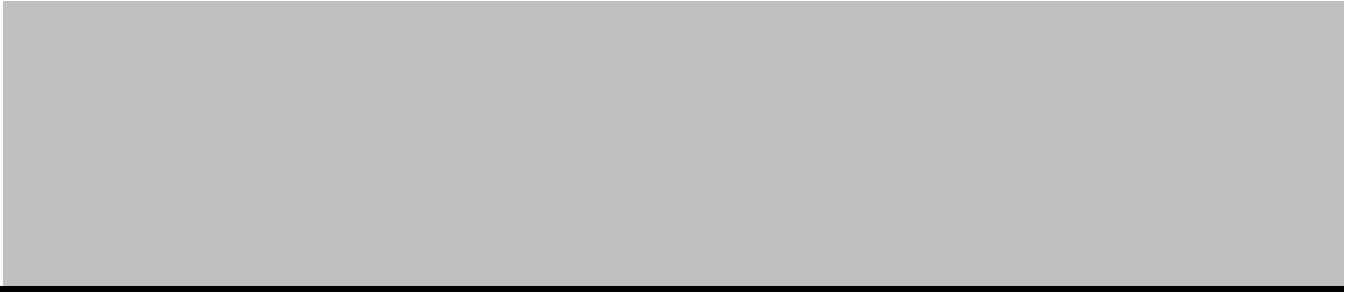


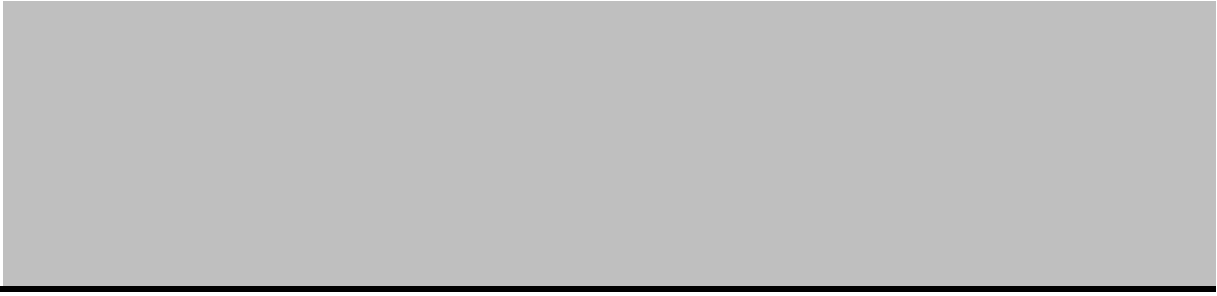


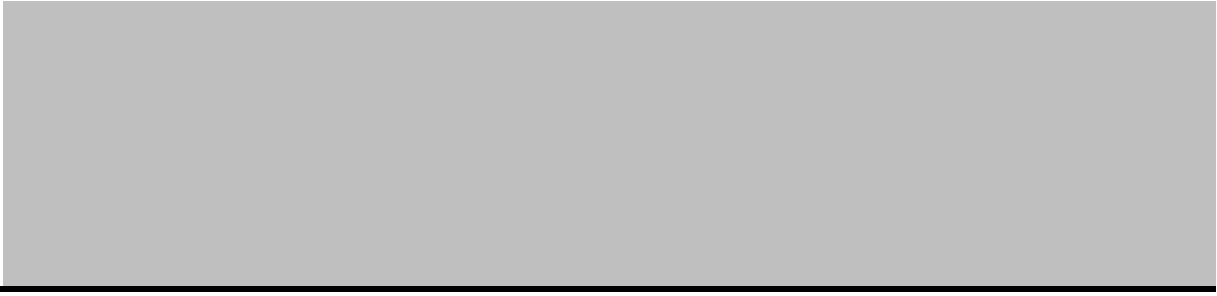


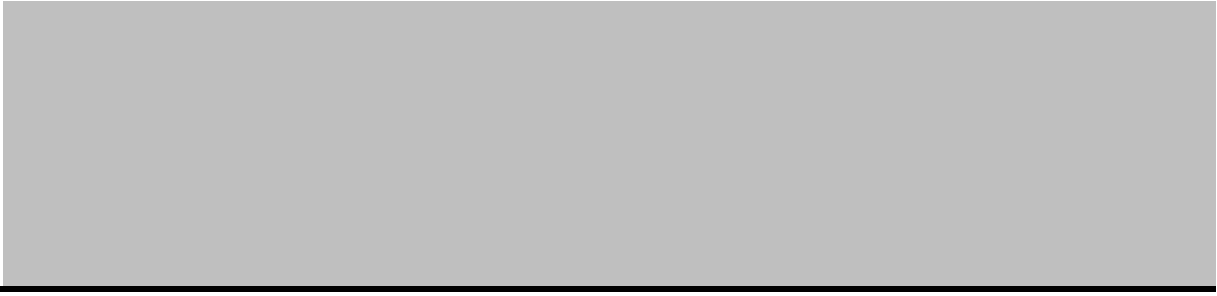


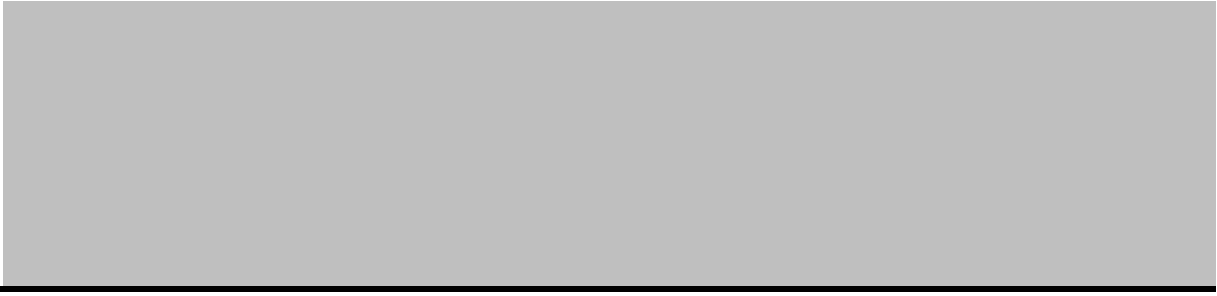


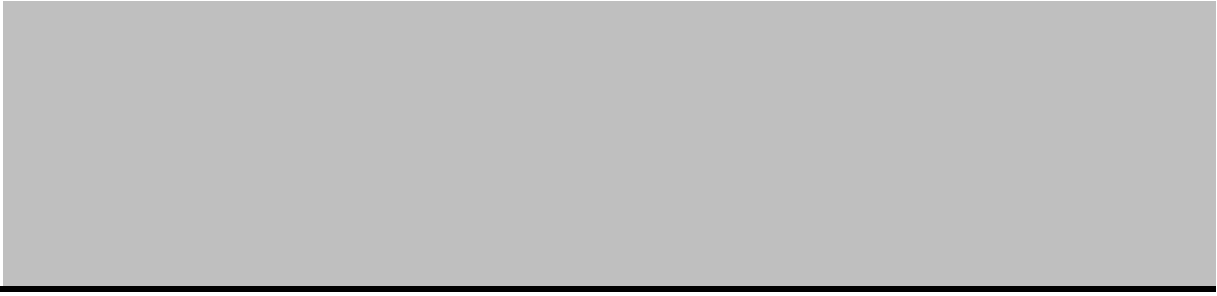


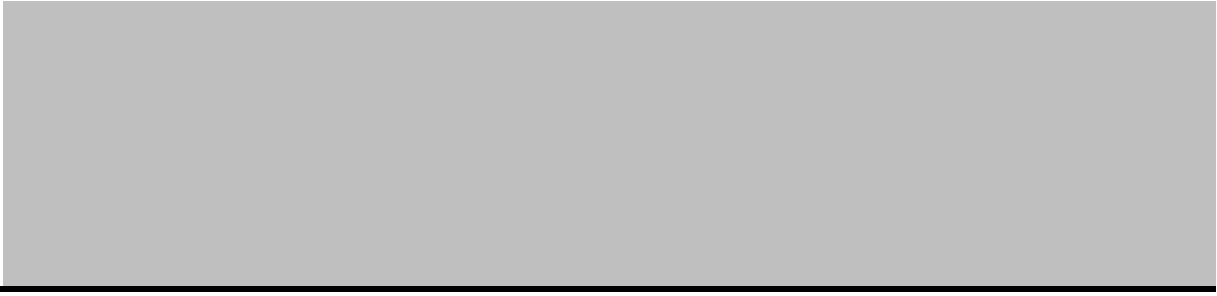


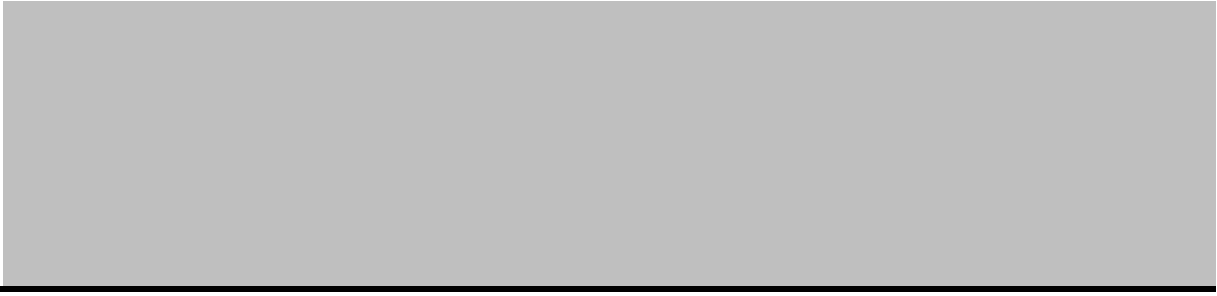


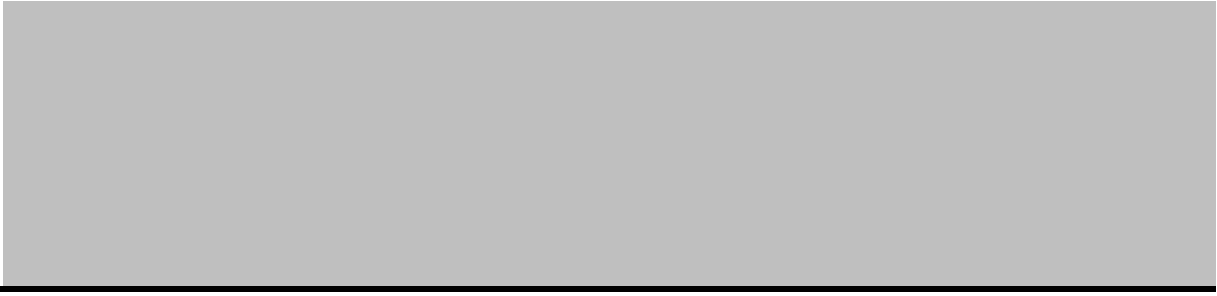


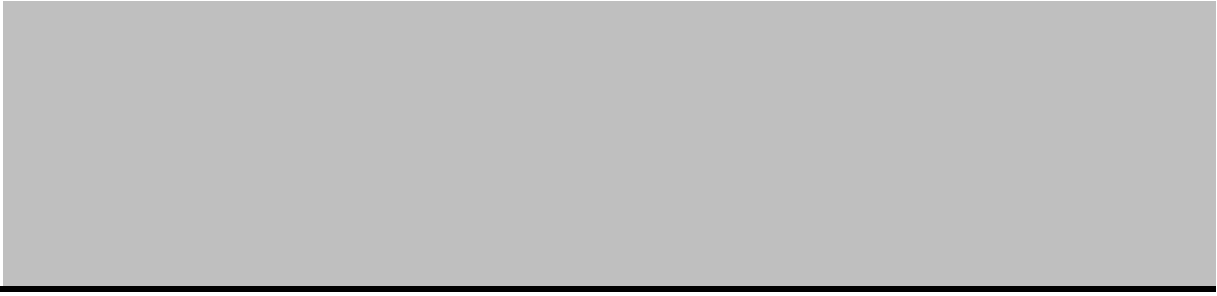


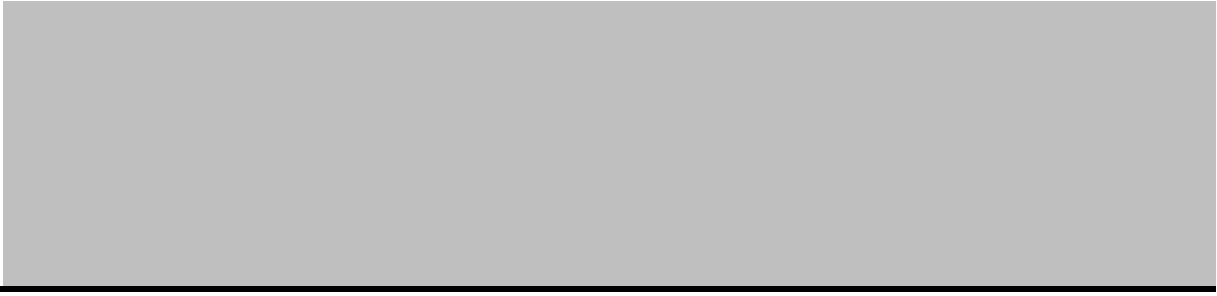


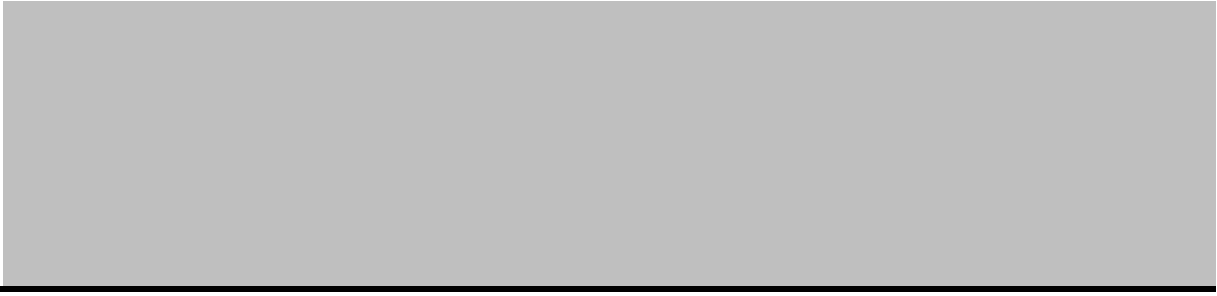


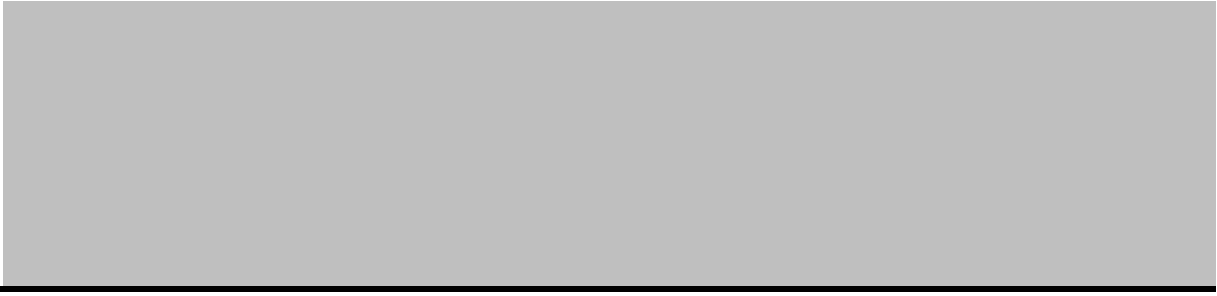


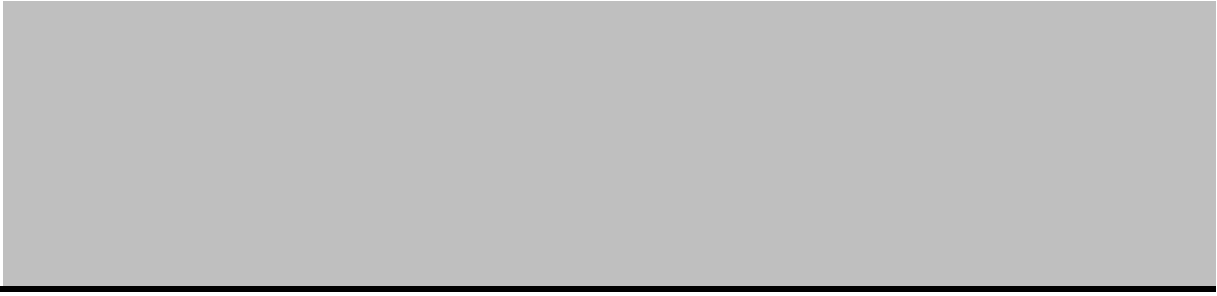


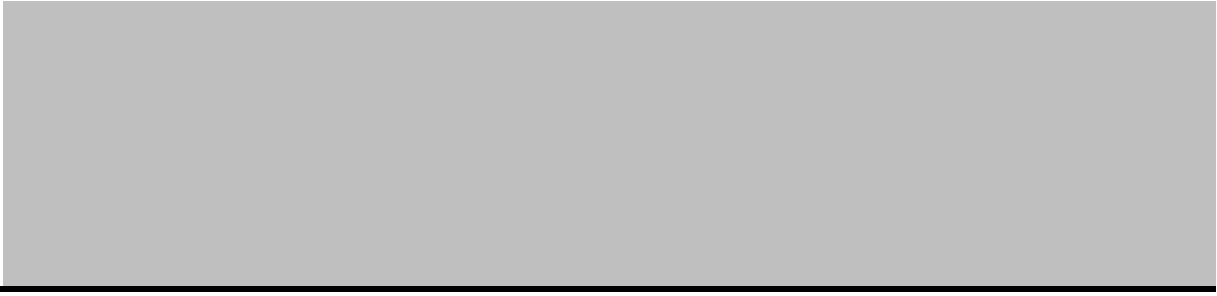


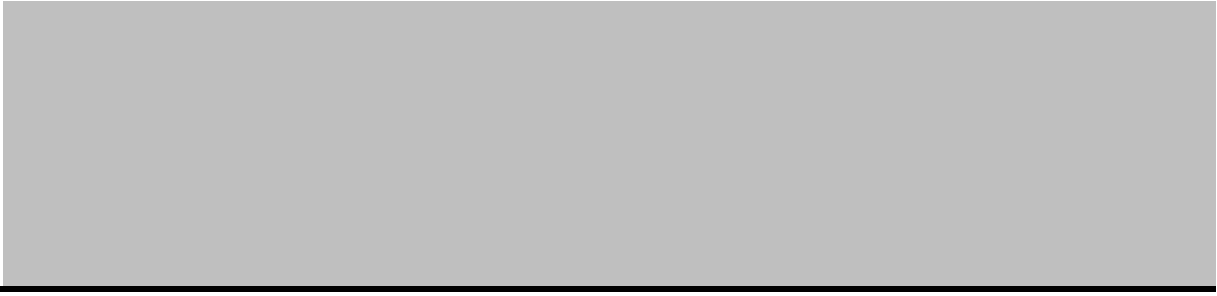


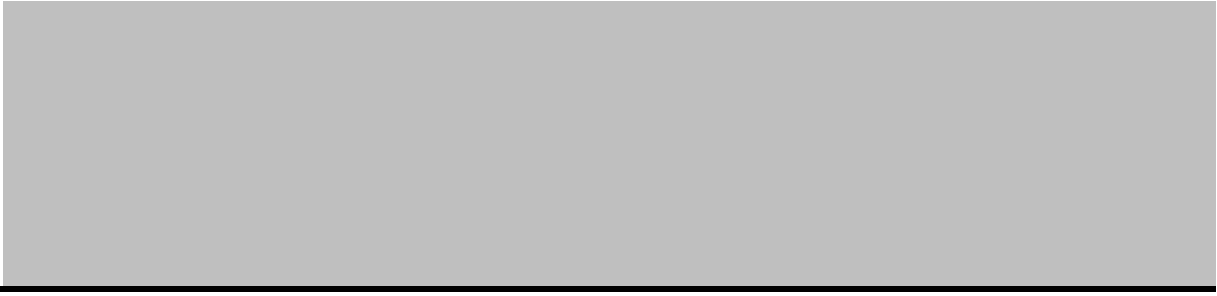


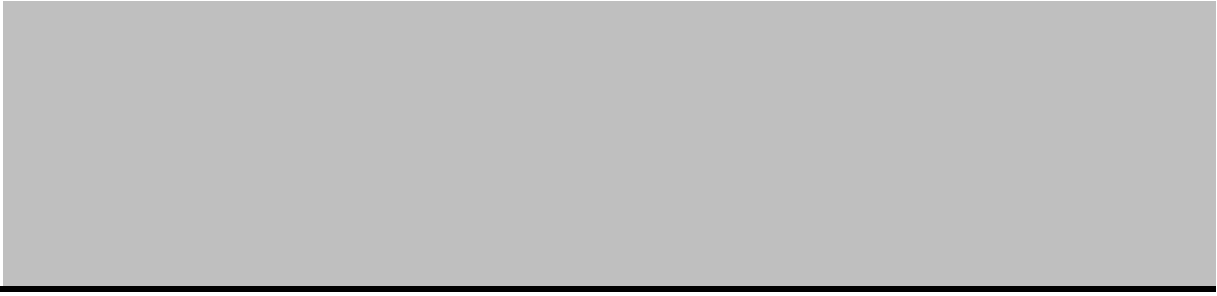


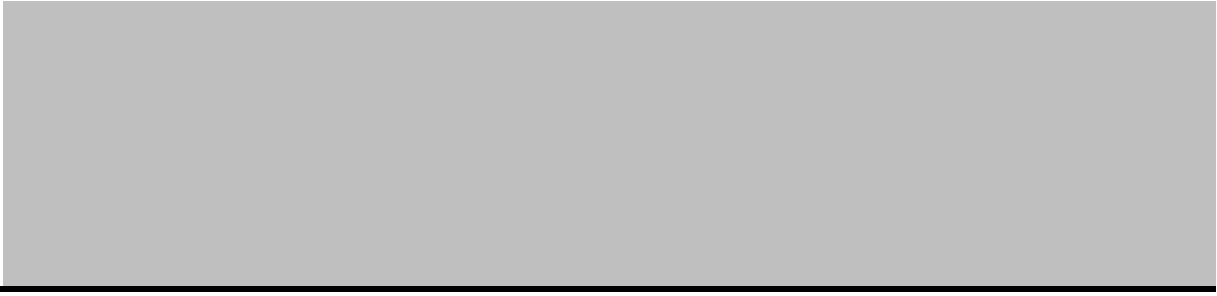


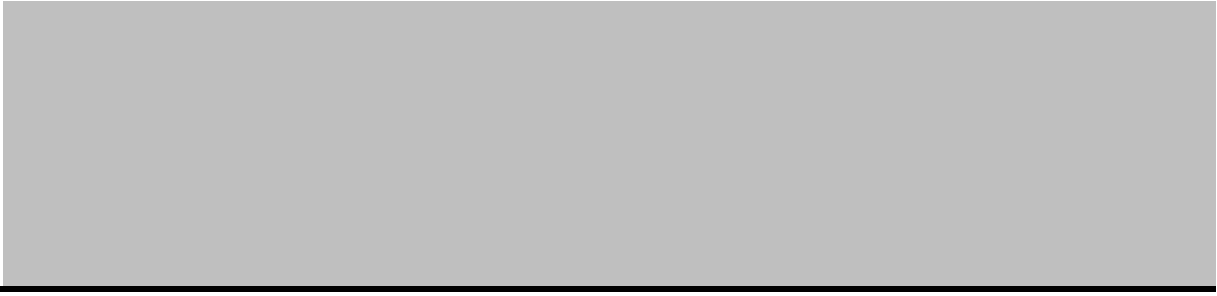


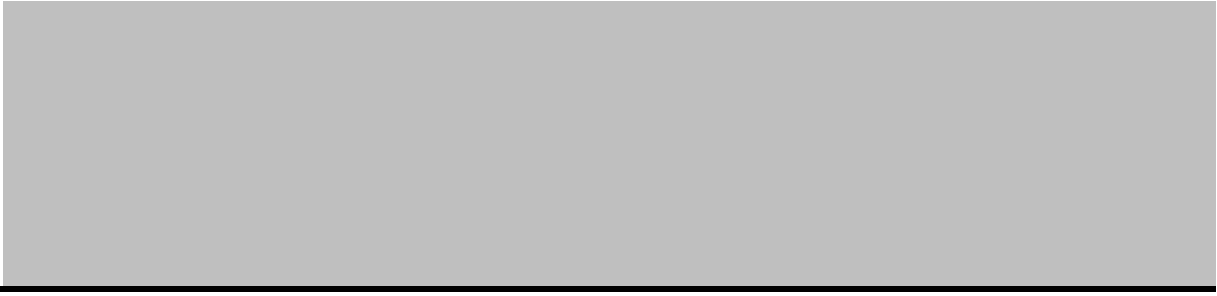


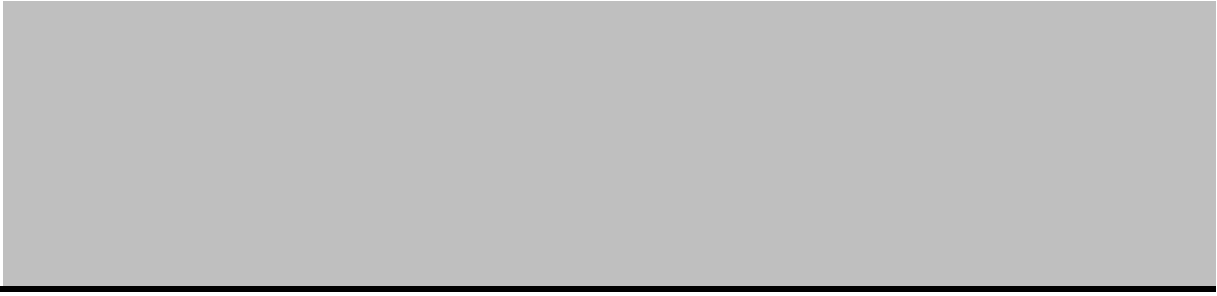


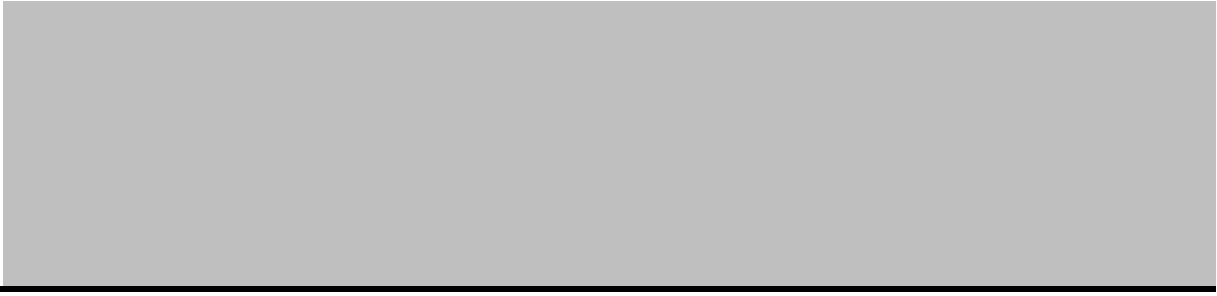


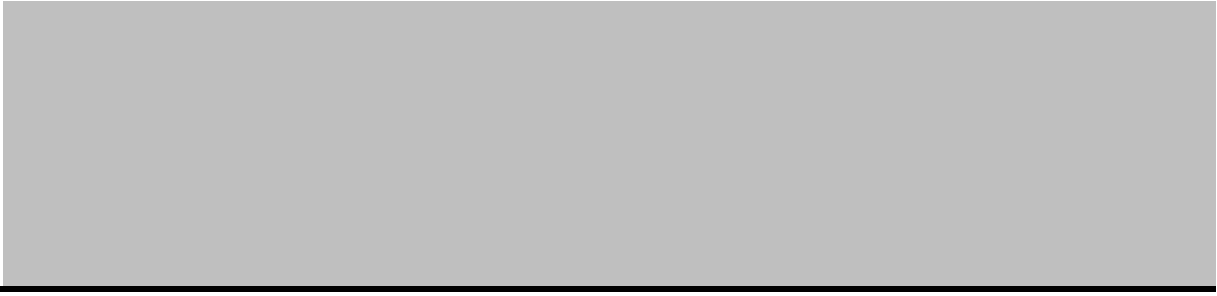


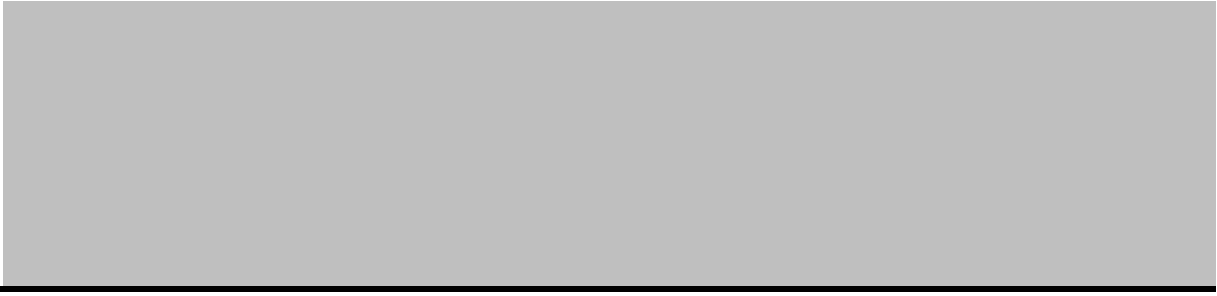


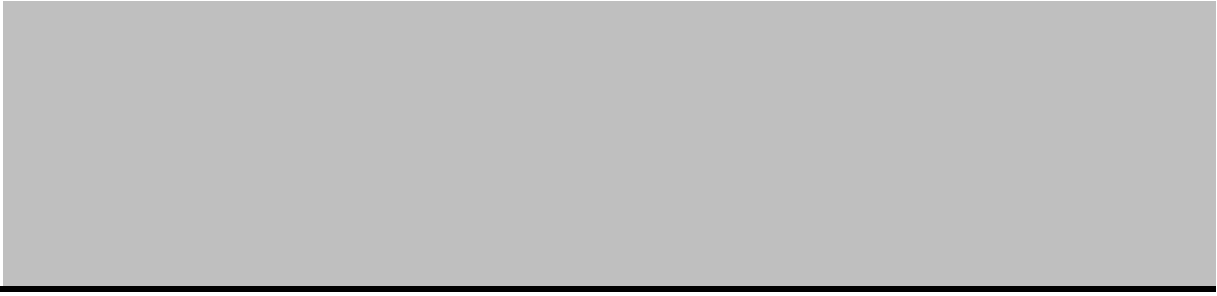


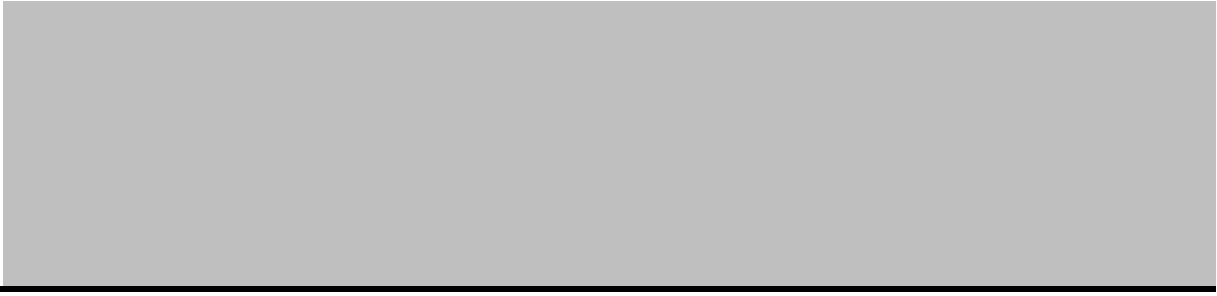


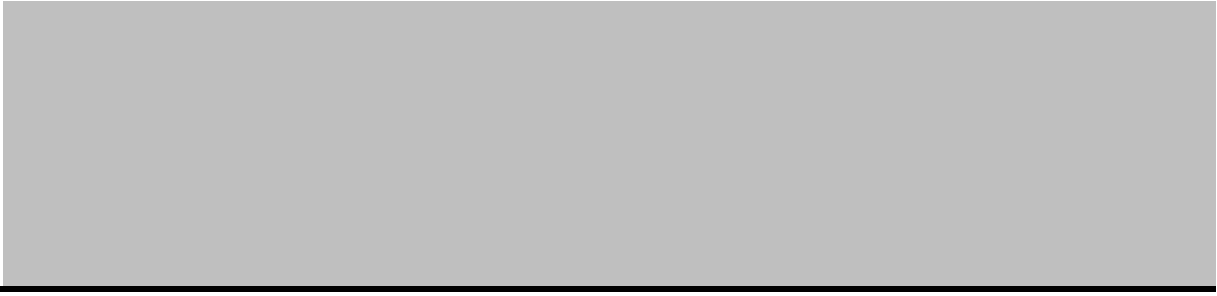


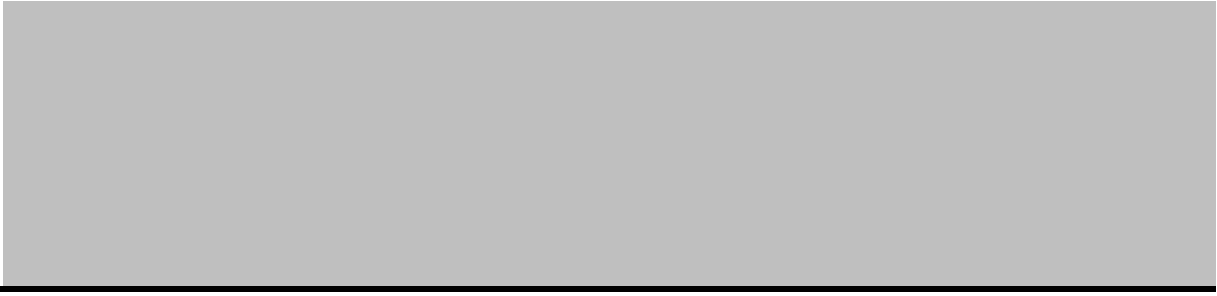


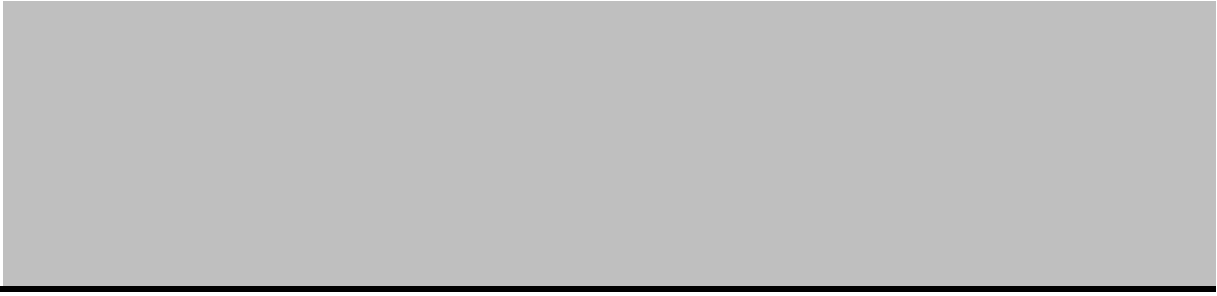


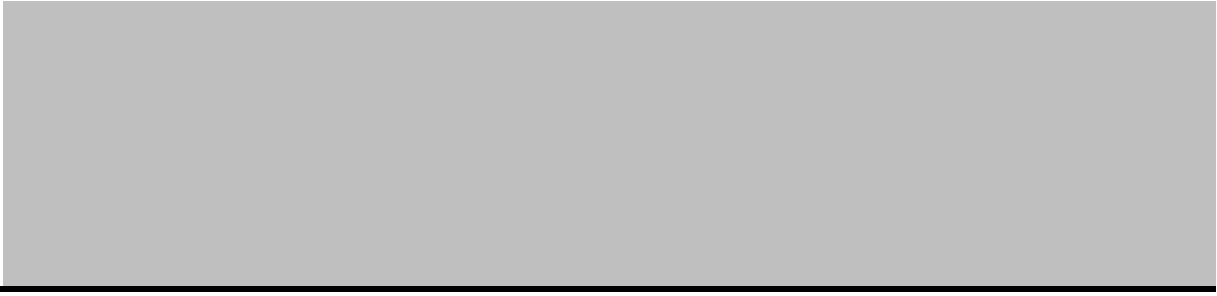


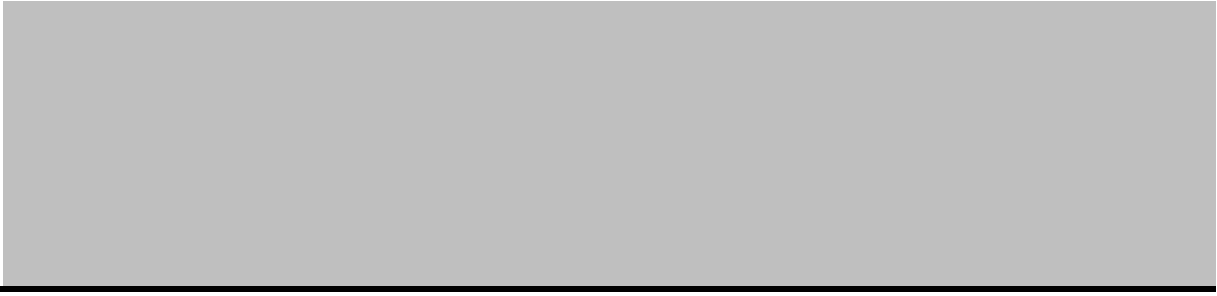


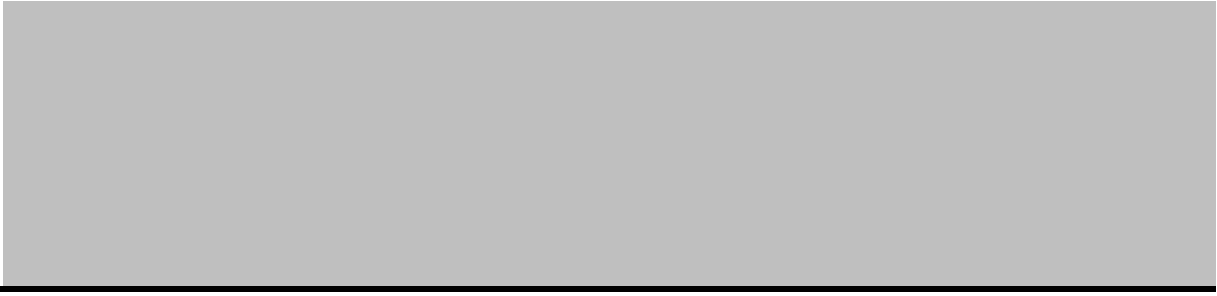


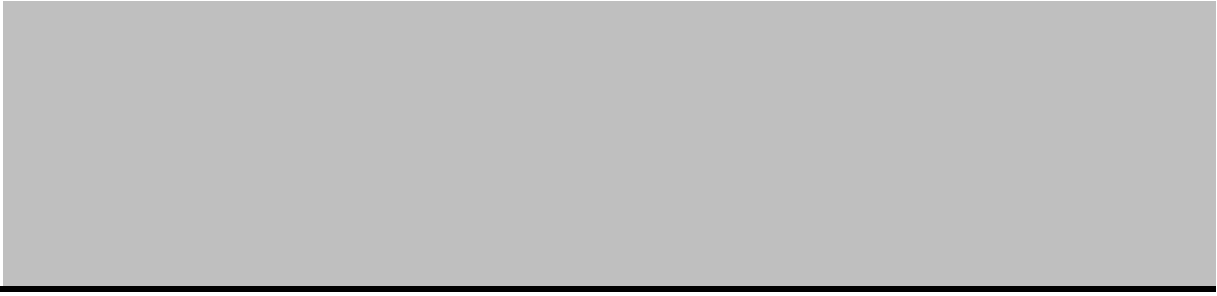


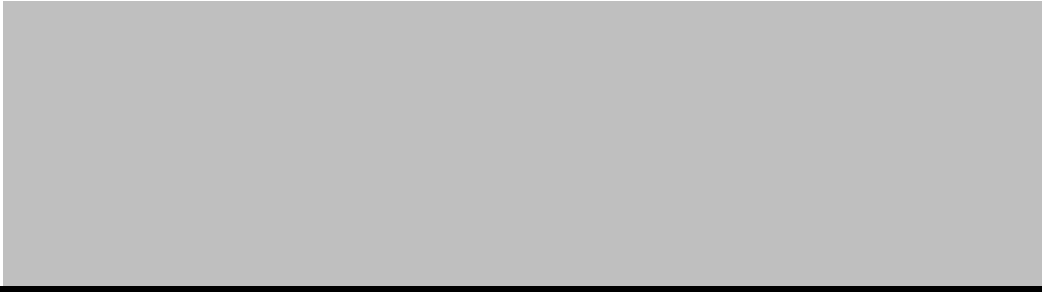












Supplemental Table S2: Raman Results + Dose Calculations for SG-027

Sample	Spot	zrc $\delta^{18}\text{O}$	zrc OH
SG-027	C15-1-LR-01	8.39	0.00014733
SG-027	C15-1-LR-02	8.39	0.00014733
SG-027	C15-1-LR-03	8.39	0.00014733
SG-027	C15-LR-2-01	7.93	0.00017270
SG-027	C15-LR-2-02	7.93	0.00017270
SG-027	C15-LR-2-03	7.93	0.00017270
SG-027	C15-1-LR-04	7.93	0.00017270
SG-027	F15-2-LR-01	8.84	0.00016690
SG-027	F15-2-LR-02	8.84	0.00016690
SG-027	F15-2-LR-03	8.84	0.00016690
SG-027	F15-2-LR-04	8.84	0.00016690
SG-027	F15-2-LR-05	8.84	0.00016690
SG-027	F15-2-LR-06	8.84	0.00016690
SG-027	F15-2-LR-07	8.84	0.00016690
SG-027	F15-2-LR-08	8.84	0.00016690
SG-027	F15-2-LR-09	8.84	0.00016690
SG-027	D13-2-LR-01	8.20	0.00016700
SG-027	D13-2-LR-02	8.20	0.00016700
SG-027	D13-2-LR-03	8.20	0.00016700
SG-027	D13-2-LR-04	8.20	0.00016700
SG-027	D13-2-LR-05	8.20	0.00016700
SG-027	D07-LR-1-01_01	8.21	0.00000886
SG-027	D07-LR-1-02_01	8.21	0.00000886
SG-027	D07-LR-1-03_01	8.21	0.00000886
SG-027	D07-LR-2-01_01	8.16	0.00008470
SG-027	D07-LR-2-02_01	8.16	0.00008470
SG-027	D07-LR-2-03_02	8.16	0.00008470
SG-027	D17-LR-1-01_01	8.36	0.00017491
SG-027	D17-LR-1-02_01	8.36	0.00017491
SG-027	D17-LR-1-03_01	8.36	0.00017491
SG-027	E04-LR-2-01	7.91	0.00019485
SG-027	E04-LR-2-02	7.91	0.00019485
SG-027	E04-LR-2-03	7.91	0.00019485
SG-027	E11-LR-1-01	8.10	0.00016595
SG-027	E11-LR-1-02	8.10	0.00016595
SG-027	E11-LR-1-03	8.10	0.00016595
SG-027	F10-LR-1-01	8.36	0.00014285
SG-027	F10-LR-1-02	8.36	0.00014285
SG-027	F10-LR-1-03	8.36	0.00014285
SG-027	F10-LR-4-01	8.25	0.00014594
SG-027	F10-LR-4-02	8.25	0.00014594
SG-027	F10-LR-4-03	8.25	0.00014594

SG-027	F10-LR-3-01_01	8.20	0.00019867
SG-027	F10-LR-3-02_01	8.20	0.00019867
SG-027	F10-LR-3-02_02	8.20	0.00019867
SG-027	F15-LR-1-01	8.35	0.00017010
SG-027	F15-LR-1-02	8.35	0.00017010
SG-027	F15-LR-1-03	8.35	0.00017010
SG-027	B14-LR-1-06	7.82	0.00019637
SG-027	B14-LR-1-07	7.82	0.00019637
SG-027	B14-LR-1-08	7.82	0.00019637
SG-027	B14-LR-1-09	7.82	0.00019637
SG-027	C15-LR-3-01_02	7.83	0.00014120
SG-027	C15-LR-3-02_01	7.83	0.00014120
SG-027	C15-LR-3-03_02	7.83	0.00014120
SG-027	E11-LR-2-01_01	8.29	0.00014889
SG-027	E11-LR-2-02_01	8.29	0.00014889
SG-027	E11-LR-2-03_01	8.29	0.00014889
SG-027	D17-LR-3-01	7.97	0.00021900
SG-027	D17-LR-3-02	7.97	0.00021900
SG-027	D17-LR-3-03	7.97	0.00021900
SG-027	D13-LR-1-01	8.27	0.00021364
SG-027	D13-LR-1-02	8.27	0.00021364
SG-027	D13-LR-1-03	8.27	0.00021364
SG-027	B14-LR-1-02	8.06	0.00020289
SG-027	B14-LR-1-03	8.06	0.00020289
SG-027	B14-LR-1-04	8.06	0.00020289
SG-027	B14-LR-1-05	8.06	0.00020289
SG-203	A02-LR1-01	7.63	0.00008435
SG-203	A02-LR1-02	7.63	0.00008435
SG-203	A02-LR1-03	7.63	0.00008435
SG-203	A02-LR2-01	7.85	0.00001426
SG-203	A02-LR2-02	7.85	0.00001426
SG-203	A02-LR2-03	7.85	0.00001426
SG-203	A02-LR3-01	7.54	0.00013515
SG-203	A02-LR3-02	7.54	0.00013515
SG-203	A02-LR3-03	7.54	0.00013515
SG-203	A03-LR-1-01	7.79	-0.00000419
SG-203	A03-LR-1-01_02	7.79	-0.00000419
SG-203	A03-LR-1-03	7.79	-0.00000419
SG-203	A03-LR-2-01	7.90	0.00005100
SG-203	A03-LR-2-02	7.90	0.00005100
SG-203	A03-LR-2-03	7.90	0.00005100
SG-203	A04-LR-2-01	7.50	0.00002174
SG-203	A04-LR-2-02	7.50	0.00002174
SG-203	A04-LR-2-03	7.50	0.00002174
SG-203	A04-LR-3-01	8.02	-0.00000154

SG-203	A04-LR-3-02	8.02	-0.00000154
SG-203	A04-LR-3-03	8.02	-0.00000154
SG-203	A04-LR-4-01	7.54	0.00011932
SG-203	A04-LR-4-02	7.54	0.00011932
SG-203	A04-LR-4-03	7.54	0.00011932
SG-203	A06-LR-2-01	8.01	0.00004624
SG-203	A06-LR-2-02	8.01	0.00004624
SG-203	A06-LR-2-03	8.01	0.00004624
SG-203	A06-LR-3-01	7.77	0.00005676
SG-203	A06-LR-3-02	7.77	0.00005676
SG-203	A06-LR-3-03	7.77	0.00005676
SG-203	A07-LR-1-01	7.99	0.00012154
SG-203	A07-LR-1-02	7.99	0.00012154
SG-203	A07-LR-1-03	7.99	0.00012154
SG-203	A07-LR-2-01	8.10	0.00003337
SG-203	A07-LR-2-02	8.10	0.00003337
SG-203	A07-LR-2-03	8.10	0.00003337
SG-203	A07-LR-3-02	8.17	-0.00001694
SG-203	A12-LR-1-01	7.74	-0.00000592
SG-203	A12-LR-1-02	7.74	-0.00000592
SG-203	A12-LR-1-03	7.74	-0.00000592
SG-203	A12-LR-2-01	7.56	-0.00001724
SG-203	A12-LR-2-02	7.56	-0.00001724
SG-203	A12-LR-3-01	8.04	0.00004155
SG-203	A12-LR-3-02	8.04	0.00004155
SG-203	A12-LR-3-03	8.04	0.00004155
SG-203	A13-LR-1-01	7.63	-0.00000689
SG-203	A13-LR-1-02	7.63	-0.00000689
SG-203	A13-LR-1-03	7.63	-0.00000689
SG-203	A13-LR-2-01	7.18	0.00013850
SG-203	A13-LR-2-02	7.18	0.00013850
SG-203	A13-LR-2-03	7.18	0.00013850
SG-203	B11-LR-1-01	7.44	0.00002632
SG-203	B11-LR-1-02	7.44	0.00002632
SG-203	B11-LR-1-03	7.44	0.00002632
SG-203	B11-LR-2-01	7.69	0.00002094
SG-203	B11-LR-2-02	7.69	0.00002094
SG-203	B11-LR-2-03	7.69	0.00002094
SG-203	B11-LR-3-01	7.72	0.00005376
SG-203	B11-LR-3-02_02	7.72	0.00005376
SG-203	B11-LR-3-03	7.72	0.00005376
SG-203	B12-LR-1-01	7.72	-0.00003765
SG-203	B12-LR-1-02	7.72	-0.00003765
SG-203	B12-LR-1-03	7.72	-0.00003765
SG-203	B12-LR-2-01	7.66	-0.00003066

SG-203	B12-LR-2-02	7.66	-0.00003066
SG-203	B12-LR-2-03	7.66	-0.00003066
SG-203	B12-LR-3-01	7.56	-0.00000702
SG-203	B12-LR-3-02	7.56	-0.00000702
SG-203	B12-LR-3-03	7.56	-0.00000702
SG-203	B18-LR-1-01	7.62	0.00002938
SG-203	B18-LR-1-02	7.62	0.00002938
SG-203	B18-LR-1-03	7.62	0.00002938
SG-203	B18-LR-2-01	7.68	-0.00003231
SG-203	B18-LR-2-02	7.68	-0.00003231
SG-203	B18-LR-2-03	7.68	-0.00003231
SG-203	B18-LR-3-01	7.48	0.00008071
SG-203	B18-LR-3-02	7.48	0.00008071
SG-203	B18-LR-3-03	7.48	0.00008071
SG-203	C17-LR-1-01	7.72	0.00000923
SG-203	C17-LR-1-02	7.72	0.00000923
SG-203	C17-LR-1-03	7.72	0.00000923
SG-203	C17-LR-1-04	7.72	0.00000923
SG-203	C17-LR-2-01	7.75	0.00002407
SG-203	C17-LR-2-02	7.75	0.00002407
SG-203	D02-LR-1-01	7.39	0.00006530
SG-203	D02-LR-1-02	7.39	0.00006530
SG-203	D02-LR-1-03	7.39	0.00006530
SG-203	D02-LR-2-01	7.89	-0.00000162
SG-203	D02-LR-2-02	7.89	-0.00000162
SG-203	D02-LR-2-03	7.89	-0.00000162
SG-203	D02-LR-3-01	7.57	0.00009309
SG-203	D02-LR-3-02	7.57	0.00009309
SG-203	D02-LR-3-03	7.57	0.00009309
SG-203	D07-LR-2-01	8.04	-0.00000293
SG-203	D07-LR-2-02	8.04	-0.00000293
SG-203	D07-LR-2-03	8.04	-0.00000293
SG-203	D12-LR-1-01	8.12	-0.00000384
SG-203	D12-LR-1-02	8.12	-0.00000384
SG-203	D12-LR-1-03	8.12	-0.00000384
SG-203	D12-LR-2-01	7.82	0.00001073
SG-203	D12-LR-2-02	7.82	0.00001073
SG-203	D12-LR-2-03	7.82	0.00001073
SG-203	E15-LR-1-01	7.65	0.00001998
SG-203	E15-LR-1-02	7.65	0.00001998
SG-203	E15-LR-1-03	7.65	0.00001998
SG-203	E15-LR-2-01	7.83	-0.00001353
SG-203	E15-LR-2-02	7.83	-0.00001353
SG-203	E15-LR-2-03	7.83	-0.00001353
SG-203	F08-LR-2-01	7.60	0.00013467

SG-203	F08-LR-2-02	7.60	0.00013467
SG-203	F08-LR-2-03	7.60	0.00013467
SG-203	F08-LR-4-01	7.62	0.00006930
SG-203	F08-LR-4-02	7.62	0.00006930
SG-203	F08-LR-4-03	7.62	0.00006930
SG-203	A06-LR-1-01	7.93	0.00000348
SG-203	A06-LR-1-02	7.93	0.00000348
SG-203	A06-LR-1-03	7.93	0.00000348
SG-203	E15-LR-3-01	7.80	0.00000230
SG-203	E15-LR-3-02	7.80	0.00000230
SG-203	E15-LR-3-03	7.80	0.00000230
SG-210c	B15-LR-1-01	5.63	0.00011612
SG-210c	B15-LR-1-02	5.63	0.00011612
SG-210c	B15-LR-2-01	5.51	0.00008040
SG-210c	B15-LR-2-02	5.51	0.00008040
SG-210c	B17-LR-1-01	5.57	0.00000468
SG-210c	B17-LR-1-02	5.57	0.00000468
SG-210c	B17-LR-1-03	5.57	0.00000468
SG-210c	C06-LR-1-01	5.41	0.00004539
SG-210c	C06-LR-1-02	5.41	0.00004539
SG-210c	C06-LR-1-03	5.41	0.00004539
SG-210c	C06-LR-2-01	5.35	-0.00001086
SG-210c	C06-LR-2-02	5.35	-0.00001086
SG-210c	C06-LR-2-03	5.35	-0.00001086
SG-210c	C08-LR-2-01	5.18	-0.00001167
SG-210c	C08-LR-2-02	5.18	-0.00001167
SG-210c	C08-LR-2-03	5.18	-0.00001167
SG-210c	D08-LR-1-01	5.24	0.00002956
SG-210c	D08-LR-1-02	5.24	0.00002956
SG-210c	D08-LR-1-03	5.24	0.00002956
SG-210c	D08-LR-2-01	5.69	0.00015334
SG-210c	D08-LR-2-02	5.69	0.00015334
SG-210c	D08-LR-2-02_02	5.69	0.00015334
SG-210c	D08-LR-3-01	5.59	0.00010061
SG-210c	D08-LR-3-02	5.59	0.00010061
SG-210c	D08-LR-3-03	5.59	0.00010061
SG-210c	D10-LR-1-01	5.12	0.00006670
SG-210c	D10-LR-1-02	5.12	0.00006670
SG-210c	D10-LR-1-03	5.12	0.00006670
SG-210c	D10-LR-2-01	5.51	0.00000579
SG-210c	D10-LR-2-02	5.51	0.00000579
SG-210c	D10-LR-2-03	5.51	0.00000579
SG-210c	D10-LR-3-01	5.72	0.00008477
SG-210c	D10-LR-3-02	5.72	0.00008477
SG-210c	D10-LR-3-03	5.72	0.00008477

SG-210c	D11-LR-1-01	5.45	0.00000285
SG-210c	D11-LR-1-02	5.45	0.00000285
SG-210c	D11-LR-1-03	5.45	0.00000285
SG-210c	D11-LR-2-01	5.50	0.00008193
SG-210c	D11-LR-2-02	5.50	0.00008193
SG-210c	D11-LR-2-03	5.50	0.00008193
SG-210c	D11-LR-3-01	5.48	0.00003396
SG-210c	D11-LR-3-02	5.48	0.00003396
SG-210c	D11-LR-3-03	5.48	0.00003396
SG-210c	D17-LR-1-01	5.43	0.00012090
SG-210c	D17-LR-1-02	5.43	0.00012090
SG-210c	D17-LR-1-03	5.43	0.00012090
SG-210c	D17-LR-2-01	5.57	0.00008165
SG-210c	D17-LR-2-02	5.57	0.00008165
SG-210c	D17-LR-2-03	5.57	0.00008165
SG-210c	E17-LR-1-01	5.36	-0.00000672
SG-210c	E17-LR-1-02	5.36	-0.00000672
SG-210c	E17-LR-1-03	5.36	-0.00000672
SG-210c	E17-LR-2-01	6.03	0.00017325
SG-210c	E17-LR-2-02	6.03	0.00017325
SG-210c	E17-LR-2-03	6.03	0.00017325
SG-210c	F01-LR-1-01	5.38	0.00005998
SG-210c	F01-LR-1-02	5.38	0.00005998
SG-210c	F01-LR-1-03	5.38	0.00005998
SG-210c	A01-LR-3-01	5.35	0.00006303
SG-210c	A01-LR-3-02	5.35	0.00006303
SG-210c	A01-LR-3-03	5.35	0.00006303
SG-210c	A01-LR-1-01	5.34	0.00004021
SG-210c	A01-LR-1-02	5.34	0.00004021
SG-210c	A01-LR-1-03	5.34	0.00004021
SG-210c	A15-LR-1-01	5.62	0.00007252
SG-210c	A15-LR-1-02	5.62	0.00007252
SG-210c	A15-LR-1-02_02	5.62	0.00007252
SG-210c	A15-LR-2-01	5.71	0.00009099
SG-210c	A15-LR-2-02	5.71	0.00009099
SG-210c	A15-LR-2-03	5.71	0.00009099
SG-210c	A15-LR-3-01	5.10	0.00015425
SG-210c	A15-LR-3-02	5.10	0.00015425
SG-210c	A15-LR-4-01	5.63	0.00003788
SG-210c	A15-LR-4-02	5.63	0.00003788
SG-210c	A15-LR-4-03	5.63	0.00003788
SG-210c	F01-LR-2-01	5.41	0.00002137
SG-210c	F01-LR-2-02	5.41	0.00002137
SG-210c	F01-LR-2-03	5.41	0.00002137
SG-210c	F05-LR-1-01	5.28	0.00007261

SG-210c	F05-LR-1-02	5.28	0.00007261
SG-210c	F05-LR-1-03	5.50	0.00016142
SG-210c	F05-LR-2-01	5.50	0.00016142
SG-210c	F05-LR-2-03	5.50	0.00016142
SG-210c	F09-LR-1-01	5.56	0.00012698
SG-210c	F09-LR-1-02	5.56	0.00012698
SG-210c	F09-LR-1-03	5.56	0.00012698
SG-210c	F09-LR-2-01	5.53	0.00010510
SG-210c	F09-LR-2-02	5.53	0.00010510
SG-210c	F09-LR-2-03	5.53	0.00010510
SG-210c	F09-LR-3-01	5.03	0.00005785
SG-210c	F09-LR-3-02	5.03	0.00005785
SG-210c	F09-LR-3-03	5.03	0.00005785
SG-210c	F10-LR-1-01	5.37	0.00004537
SG-210c	F10-LR-1-02	5.37	0.00004537
SG-210c	F10-LR-1-03	5.37	0.00004537
SG-210c	F10-LR-2-01	5.28	0.00000736
SG-210c	F10-LR-2-02	5.28	0.00000736
SG-210c	F10-LR-2-03	5.28	0.00000736
SG-210c	F10-LR-3-01	5.23	0.00000283
SG-210c	F10-LR-3-02	5.23	0.00000283
SG-210c	F10-LR-3-03	5.23	0.00000283
SG-210c	F10-LR-4-01	5.07	0.00004393
SG-210c	F10-LR-4-02	5.07	0.00004393
SG-210c	F10-LR-4-03	5.07	0.00004393
SG-210c	F13-LR-1-01	5.31	0.00000460
SG-210c	F13-LR-1-02	5.31	0.00000460
SG-210c	F13-LR-1-03	5.31	0.00000460
SG-210c	F13-LR-2-01	5.32	0.00003434
SG-210c	F13-LR-2-02	5.32	0.00003434
SG-210c	F13-LR-2-03	5.32	0.00003434
SG-210c	F13-LR-3-01	5.33	0.00001217
SG-210c	F13-LR-3-02	5.33	0.00001217
SG-210c	F13-LR-3-03	5.33	0.00001217
SG-210c	F13-LR-4-01	5.47	0.00000351
SG-210c	F13-LR-4-02	5.47	0.00000351
SG-210c	F13-LR-4-03	5.47	0.00000351
SG-210c	F14-LR-1-01	5.37	-0.00000320
SG-210c	F14-LR-1-02	5.37	-0.00000320
SG-210c	F14-LR-1-03	5.37	-0.00000320
SG-210c	F14-LR-2-01	5.22	0.00001619
SG-210c	F14-LR-2-02	5.22	0.00001619
SG-210c	F14-LR-2-03	5.22	0.00001619
SG-210c	F14-LR-3-01	5.29	-0.00001589
SG-210c	F14-LR-3-02	5.29	-0.00001589

SG-210c	F14-LR-3-03	5.29	-0.00001589
SG-210c	F14-LR-4-01	5.40	-0.00000789
SG-210c	F14-LR-4-02	5.40	-0.00000789
SG-210c	F14-LR-4-03	5.40	-0.00000789
SG-210c	C10-LR-2-01	5.97	0.00015952
SG-210c	C10-LR-2-02	5.97	0.00015952
SG-210c	C10-LR-2-03	5.97	0.00015952



, SG-210c, SG-203

notes on placement	Wavenumber Shift (cm ⁻¹)	FWHM ₁₀₀₈ (cm ⁻¹) (Meas.)	ApF
O spot 1	995.071	25.2205	0.8
O spot 1	994.905	20.9722	0.8
O spot 1	994.498	21.6882	0.8
O spot 2	995.348	21.0552	0.8
O spot 2	995.466	20.5108	0.8
O spot 2	995.579	20.6538	0.8
O spot 2	995.603	26.7028	0.8
O spot 2	993.399	27.6216	0.8
O spot 2	993.985	27.3128	0.8
O spot 2	993.8245	27.7083	0.8
O spot 2	992.646	28.2518	0.8
O spot 2	993.133	29.5583	0.8
O spot 2	992.514	26.4559	0.8
O spot 2	993.211	27.3997	0.8
O spot 2	993.793	24.9409	0.8
O spot 2	993.217	28.7353	0.8
O spot 2	993.594	22.4134	0.8
O spot 2	992.663	26.0751	0.8
O spot 2	992.835	25.182	0.8
O spot 2	994.715	21.7676	0.8
O spot 2	994.44	23.6587	0.8
O spot 1	1006.09	4.63024	0.8
O spot 1	1005.29	4.52888	0.8
O spot 1	1006.23	4.41586	0.8
O spot 2	998.998	14.3962	0.8
O spot 2	998.102	14.8336	0.8
O spot 2	997.45	18.2722	0.8
O spot 1	998.966	14.7339	0.8
O spot 1	995.632	19.7016	0.8
O spot 1	995.016	19.001	0.8
O spot 2	994.74	29.0732	0.8
O spot 2	994.498	30.884	0.8
O spot 2	995.189	29.2948	0.8
O spot 1	994.609	28.6159	0.8
O spot 1	995.021	29.0004	0.8
O spot 1	994.247	28.5004	0.8
O spot 1	993.925	27.6147	0.8
O spot 1	993.064	25.3476	0.8
O spot 1	992.874	27.8284	0.8
O spot 4	996.134	21.0835	0.8
O spot 4	994.847	23.9766	0.8
O spot 4	995.327	23.0795	0.8

O spot 3	993.002	32.093	0.8
O spot 3	991.833	28.2683	0.8
O spot 3	993.051	30.6123	0.8
O spot 1	992.625	24.3721	0.8
O spot 1	992.85	25.8972	0.8
O spot 1	993.031	21.8438	0.8
corr with d18O spot 3, rim	994.75	31.8018	0.8
corr with d18O spot 3, rim	994.785	31.4987	0.8
corr with d18O spot 3, rim	994.582	31.3217	0.8
corr with d18O spot 3, rim	995.47	30.0994	0.8
O spot 3, rim	995.951	18.5424	0.8
O spot 3, rim	996.179	19.6201	0.8
O spot 3, rim	996.969	17.0992	0.8
O spot 2, rim	994.809	22.8956	0.8
O spot 2, rim	994.63	23.8578	0.8
O spot 2, rim	996.173	18.5474	0.8
O spot 3	1003.75	10.299	0.8
O spot 3	1000.99	16.3047	0.8
O spot 3	1002.75	6.03817	0.8
O spot 1	993.463	27.8818	0.8
O spot 1	993.284	27.967	0.8
O spot 1	993.363	27.3277	0.8
corr with d18O spot 2	994.692	29.1606	0.8
corr with d18O spot 2	993.874	28.0251	0.8
corr with d18O spot 2	994.078	27.3859	0.8
corr with d18O spot 2	994.917	23.1396	0.8
O spot 1	1000.11	16.4296	0.8
O spot 1	1001.62	12.2207	0.8
O spot 1	1001.72	16.41	0.8
O spot 2	1005.2	6.65093	0.8
O spot 2	1002.82	9.10832	0.8
O spot 2	1001.81	10.479	0.8
O spot 3	1001.32	10.7251	0.8
O spot 3	1003.87	7.75993	0.8
O spot 3	996.204	27.5356	0.8
O spot 1	1005.21	5.78359	0.8
O spot 1	1005.02	5.66636	0.8
O spot 1	1005.09	5.44816	0.8
O spot 2	1004.11	7.39277	0.8
O spot 2	1003.29	6.59701	0.8
O spot 2	1003.37	8.90706	0.8
O spot 2	1000.35	16.7483	0.8
O spot 2	1001.99	12.4765	0.8
O spot 2	1001.66	12.3212	0.8
O spot 3	1005.44	6.32631	0.8

O spot 3	1007.17	4.41427	0.8
O spot 3	1002.75	9.08723	0.8
O spot 4	1000.29	11.829	0.8
O spot 4	1003.1	7.81018	0.8
O spot 4	996.632	27.2748	0.8
O spot 2	1005.06	6.33941	0.8
O spot 2	1006.29	4.94109	0.8
O spot 2	1006.83	4.22231	0.8
O spot 3	1005.08	5.97461	0.8
O spot 3	1004.01	7.20505	0.8
O spot 3	1003.2	9.90042	0.8
O spot 1	1004.12	6.65588	0.8
O spot 1	1004.21	7.80519	0.8
O spot 1	1005.82	4.84968	0.8
O spot 2	1005.53	4.68366	0.8
O spot 2	1005.64	5.57288	0.8
O spot 2	1005.47	5.55923	0.8
O spot 3	1005.76	4.72499	0.8
O spot 1	1005.7	4.96105	0.8
O spot 1	1005.43	5.38959	0.8
O spot 1	1005.53	5.14105	0.8
O spot 2	1005.32	5.39274	0.8
O spot 2	1004.48	6.54119	0.8
O spot 3	1005.83	5.34624	0.8
O spot 3	1005.33	5.91302	0.8
O spot 3	1005.78	4.42244	0.8
O spot 1	1006.22	4.18081	0.8
O spot 1	1004.37	7.2169	0.8
O spot 1	1005.99	4.31259	0.8
O spot 2	996.345	19.9038	0.8
O spot 2	1003.23	8.82733	0.8
O spot 2	997.221	13.329	0.8
O spot 1	1005.28	4.25567	0.8
O spot 1	1005.45	7.25543	0.8
O spot 1	1005.39	5.3794	0.8
O spot 2	1005.93	4.9847	0.8
O spot 2	1005.75	4.80225	0.8
O spot 2	1004.92	5.98608	0.8
O spot 3	1004.7	5.53015	0.8
O spot 3	1003.01	8.71242	0.8
O spot 3	1003.22	9.67972	0.8
O spot 1	1006.71	3.40699	0.8
O spot 1	1006.97	3.25336	0.8
O spot 1	1006.39	3.9714	0.8
O spot 2	1006.79	3.94952	0.8

O spot 2	1006.99	4.26544	0.8
O spot 2	1006.88	4.12781	0.8
O spot 3	1005.7	5.14914	0.8
O spot 3	1005.45	4.93409	0.8
O spot 3	1003.9	7.63783	0.8
O spot 1	1005.44	5.92172	0.8
O spot 1	1005.66	5.92912	0.8
O spot 1	1005.84	4.2343	0.8
O spot 2	1005.87	5.11904	0.8
O spot 2	1005.94	5.27592	0.8
O spot 2	1006.83	4.09123	0.8
O spot 3	1001.07	14.3969	0.8
O spot 3	1003.38	8.92755	0.8
O spot 3	1003.07	9.17946	0.8
O spot 1	1004.33	6.8274	0.8
O spot 1	1004.27	7.51098	0.8
TE spot	1003.84	5.81928	0.8
TE spot	1004.54	6.7532	0.8
O spot 2	1001.86	16.1535	0.8
O spot 2	1004.65	6.05053	0.8
O spot 1	1003.4	9.0347	0.8
O spot 1	1003.02	11.3541	0.8
O spot 1	1003.26	9.31017	0.8
O spot 2	1005.24	6.03474	0.8
O spot 2	1002.13	10.1519	0.8
O spot 2	1005.13	6.51207	0.8
O spot 3	1003.16	8.308	0.8
O spot 3	1003.74	7.74437	0.8
O spot 3	1001.45	11.6071	0.8
O spot 2	1002.14	11.4123	0.8
O spot 2	1005.82	4.72262	0.8
O spot 2	1005.36	4.93092	0.8
O spot 1	1006.54	4.0014	0.8
O spot 1	1005.85	5.02916	0.8
O spot 1	1005.66	5.22638	0.8
O spot 2	1005.05	5.98224	0.8
O spot 2	1005.28	6.095	0.8
O spot 2	1004.92	5.99047	0.8
O spot 1	1006.8	4.21328	0.8
O spot 1	1006.83	4.13542	0.8
O spot 1	1006.68	4.82066	0.8
O spot 2	1006.87	3.71105	0.8
O spot 2	1006.87	3.71105	0.8
O spot 2	1005.97	4.65205	0.8
O spot 2	997.233	14.7496	0.8

O spot 2	995.573	17.6963	0.8
O spot 2	1005.17	5.79369	0.8
O spot 4	1002.74	10.0262	0.8
O spot 4	1003.97	7.26852	0.8
O spot 4	1002.36	9.94858	0.8
O spot 1	1005.89	4.88888	0.8
O spot 1	1005.96	5.24924	0.8
O spot 1	1006.04	4.89381	0.8
O spot 3	1006.7	4.85376	0.8
O spot 3	1006.59	4.61764	0.8
O spot 3	1006.76	4.48733	0.8
O spot 1	1004.74	6.4853	0.8
O spot 1	1004.42	6.94162	0.8
O spot 2	1004.91	6.74245	0.8
O spot 2	1004.1	7.75641	0.8
O spot 1	1005.96	4.6011	0.8
O spot 1	1006.13	4.36295	0.8
O spot 1	1005.49	5.11119	0.8
O spot 1	1003.8	7.8467	0.8
O spot 1	1004.96	7.19558	0.8
O spot 1	1004.52	7.33115	0.8
O spot 2	1004.15	7.58036	0.8
O spot 2	1006.37	4.8167	0.8
O spot 2	1005.8	6.4166	0.8
O spot 2	1005.95	4.70616	0.8
O spot 2	1006.36	3.96284	0.8
O spot 2	1006.41	4.20281	0.8
O spot 1	1005.72	5.31144	0.8
O spot 1	1004.22	7.56513	0.8
O spot 1	1004.24	7.91687	0.8
O spot 2	1003.58	8.27329	0.8
O spot 2	1003.41	8.76043	0.8
O spot 2	1003.79	7.95287	0.8
O spot 3	1003.37	9.18657	0.8
O spot 3	1002.5	9.5559	0.8
O spot 3	1002.97	8.91062	0.8
O spot 1	1003.4	8.178	0.8
O spot 1	1003.34	9.08587	0.8
O spot 1	1002.48	10.0216	0.8
O spot 2	1004.96	5.00726	0.8
O spot 2	1005.43	5.80842	0.8
O spot 2	1005.13	6.10346	0.8
O spot 3	1006.37	4.15934	0.8
O spot 3	1005.15	7.043	0.8
O spot 3	1006.61	3.35891	0.8

O spot 1	1003.74	9.34073	0.8
O spot 1	1003.79	4.7155	0.8
O spot 1	1003.9	6.50073	0.8
O spot 2	1002.88	9.73047	0.8
O spot 2	1005.65	4.32339	0.8
O spot 2	1003.37	9.67156	0.8
O spot 3	1004.81	6.38569	0.8
O spot 3	1004.69	7.36527	0.8
O spot 3	1004.43	7.60472	0.8
O spot 1	1002.94	8.634	0.8
O spot 1	1003.48	7.14947	0.8
O spot 1	1004.86	6.02138	0.8
O spot 2	1004.6	6.4416	0.8
O spot 2	1003.61	8.89121	0.8
O spot 2	1003.86	9.30535	0.8
O spot 1	1004.83	5.79106	0.8
O spot 1	1004.13	5.5443	0.8
O spot 1	1004.53	6.15137	0.8
O spot 2	1001.7	11.8329	0.8
O spot 2	1002.66	8.64676	0.8
O spot 2	1004.5	6.90838	0.8
O spot 1	1002.89	9.64307	0.8
O spot 1	1003.02	9.29891	0.8
O spot 1	1003.43	9.87628	0.8
O spot 3	1004.6	6.89491	0.8
O spot 3	1000.84	15.0642	0.8
O spot 3	999.786	15.3714	0.8
O spot 1	1005.12	6.51637	0.8
O spot 1	1004.31	5.53366	0.8
O spot 1	1003.77	6.78717	0.8
O spot 1	1005.57	5.65857	0.8
O spot 1	1005.57	5.74258	0.8
O spot 1	1005.69	5.78836	0.8
O spot 2	1004.57	6.66656	0.8
O spot 2	1005.16	6.63233	0.8
O spot 2	1004.58	6.6457	0.8
O spot 3	999.3	17.5002	0.8
O spot 3	999.595	17.7849	0.8
O spot 4	1005.89	5.14469	0.8
O spot 4	1006.08	5.04615	0.8
O spot 4	1006.15	4.86575	0.8
O spot 2	1003.44	10.1015	0.8
O spot 2	1004.29	7.00951	0.8
O spot 2	1005.5	6.36966	0.8
O spot 1	1002.33	10.7935	0.8

O spot 1	1002.75	9.79671	0.8
O spot 1	1000.6	13.5921	0.8
O spot 2	1003.81	10.5394	0.8
O spot 2	1000.7	16.045	0.8
O spot 1	1002.87	9.63324	0.8
O spot 1	1003.71	7.46802	0.8
O spot 1	1003.68	9.11804	0.8
O spot 2	1003.39	10.476	0.8
O spot 2	1001.34	10.442	0.8
O spot 2	1002.73	10.3764	0.8
O spot 3	1002.31	9.15375	0.8
O spot 3	1001.64	12.162	0.8
O spot 3	1003	8.92786	0.8
O spot 1	1004.9	7.54074	0.8
O spot 1	1004.95	6.98659	0.8
O spot 1	1004.9	7.81788	0.8
O spot 2	1005.3	6.50893	0.8
O spot 2	1004.28	7.14523	0.8
O spot 2	1005	7.81211	0.8
O spot 3	1004.76	6.97794	0.8
O spot 3	1003.96	7.5456	0.8
O spot 3	1004.74	6.16194	0.8
O spot 4	1002.89	9.2354	0.8
O spot 4	1003.39	8.24316	0.8
O spot 4	1002.53	11.1507	0.8
O spot 1	1004.99	6.89104	0.8
O spot 1	1004.83	7.17258	0.8
O spot 1	1005.1	6.24423	0.8
O spot 2	1003.98	8.31437	0.8
O spot 2	1003.9	8.35118	0.8
O spot 2	1004.28	7.94681	0.8
O spot 3	1004.78	5.93686	0.8
O spot 3	1004.11	6.29929	0.8
O spot 3	1005.2	5.11156	0.8
O spot 4	1003.79	8.6695	0.8
O spot 4	1003.95	8.04089	0.8
O spot 4	1004.06	8.93698	0.8
O spot 1	1005.7	5.9452	0.8
O spot 1	1004.34	7.73721	0.8
O spot 1	1004.98	6.6053	0.8
O spot 2	1004.12	8.96449	0.8
O spot 2	1004.63	9.19735	0.8
O spot 2	1004.48	9.08994	0.8
O spot 3	1004.66	7.06646	0.8
O spot 3	1005.22	6.49819	0.8

O spot 3	1004.77	7.36463	0.8
O spot 4	1004.68	7.38378	0.8
O spot 4	1005.13	6.50038	0.8
O spot 4	1004.54	7.62813	0.8
O spot 2	1000.08	15.0909	0.8
O spot 2	1002.28	10.5362	0.8
O spot 2	998.649	18.1477	0.8



$D_{\text{eff}} (10^{15} \alpha\text{-decays/mg})$ Nasdala et al. 2001 (eqn. 6)	$D_{\text{eff}} (10^{15} \alpha\text{-decays/mg})$ Palenik et al. 2003 (eqn. 4)	$\text{FWHM}_{1008} (\text{cm}^{-1}) (\text{Corr.})$ (Vaczi 2014 eqn 5b)	<i>avg shift per $\delta 180$ spot</i>
1.71	2.24	25.19	994.82
1.41	1.61	20.94	
1.46	1.70	21.66	
1.42	1.62	21.02	995.50
1.38	1.56	20.48	
1.39	1.57	20.62	
1.82	2.51	26.68	
1.89	2.71	27.60	993.30
1.86	2.64	27.29	
1.89	2.73	27.68	
1.93	2.86	28.23	
2.02	3.21	29.53	
1.80	2.46	26.43	
1.87	2.66	27.37	
1.69	2.19	24.91	
1.97	2.98	28.71	
1.51	1.80	22.38	993.65
1.77	2.39	26.05	
1.71	2.23	25.15	
1.47	1.71	21.74	
1.60	1.98	23.63	
0.23	0.24	4.48	1005.87
0.23	0.24	4.37	
0.22	0.23	4.26	
0.94	0.94	14.35	998.18
0.97	0.98	14.79	
1.22	1.31	18.23	
0.96	0.97	14.69	996.54
1.32	1.46	19.67	
1.27	1.38	18.96	
1.99	3.07	29.05	994.81
2.12	3.66	30.86	
2.01	3.14	29.27	
1.96	2.95	28.59	994.63
1.98	3.05	28.98	
1.95	2.92	28.48	
1.88	2.71	27.59	993.29
1.72	2.26	25.32	
1.90	2.76	27.80	
1.42	1.63	21.05	995.44
1.62	2.03	23.95	
1.56	1.90	23.05	

2.21	4.19	32.07	992.63
1.93	2.86	28.24	
2.10	3.56	30.59	
1.65	2.09	24.34	992.84
1.76	2.36	25.87	
1.47	1.72	21.81	
2.18	4.05	31.78	994.90
2.16	3.91	31.48	
2.15	3.83	31.30	
2.06	3.38	30.08	
1.24	1.33	18.50	996.37
1.31	1.45	19.58	
1.13	1.19	17.06	
1.55	1.87	22.86	995.20
1.62	2.01	23.83	
1.24	1.33	18.51	
0.65	0.62	10.23	1002.50
1.08	1.11	16.26	
0.34	0.33	5.92	
1.90	2.77	27.86	993.37
1.91	2.79	27.94	
1.86	2.65	27.30	
2.00	3.10	29.14	994.39
1.91	2.81	28.00	
1.87	2.66	27.36	
1.56	1.90	23.11	
1.08	1.12	16.39	1001.15
0.78	0.76	12.16	
1.08	1.12	16.37	
0.38	0.37	6.55	1003.28
0.56	0.53	9.03	
0.66	0.63	10.41	
0.68	0.65	10.66	1000.46
0.46	0.44	7.67	
1.88	2.69	27.51	
0.32	0.32	5.66	1005.11
0.31	0.31	5.54	
0.29	0.29	5.32	
0.44	0.42	7.30	1003.59
0.38	0.37	6.49	
0.54	0.52	8.83	
1.11	1.15	16.71	1001.33
0.80	0.78	12.42	
0.79	0.77	12.26	
0.36	0.35	6.22	1005.12

0.22	0.23	4.26	
0.56	0.53	9.01	
0.75	0.73	11.77	1000.01
0.47	0.44	7.72	
1.86	2.63	27.25	
0.36	0.35	6.23	1006.06
0.26	0.26	4.80	
0.20	0.22	4.06	
0.33	0.33	5.86	1004.10
0.42	0.41	7.11	
0.62	0.59	9.83	
0.38	0.37	6.55	1004.72
0.47	0.44	7.72	
0.25	0.26	4.71	
0.24	0.25	4.53	1005.55
0.30	0.30	5.45	
0.30	0.30	5.43	
0.24	0.25	4.58	1005.76
0.26	0.26	4.82	1005.55
0.29	0.29	5.26	
0.27	0.28	5.01	
0.29	0.29	5.26	1004.90
0.37	0.36	6.43	
0.29	0.29	5.22	1005.65
0.33	0.32	5.79	
0.22	0.23	4.26	
0.20	0.22	4.01	1005.53
0.42	0.41	7.12	
0.21	0.23	4.15	
1.33	1.48	19.87	998.93
0.54	0.51	8.75	
0.86	0.85	13.28	
0.21	0.22	4.09	1005.37
0.43	0.41	7.16	
0.29	0.29	5.25	
0.26	0.27	4.84	1005.53
0.25	0.26	4.66	
0.33	0.33	5.87	
0.30	0.30	5.40	1003.64
0.53	0.51	8.63	
0.60	0.57	9.61	
0.14	0.17	3.20	1006.69
0.13	0.16	3.04	
0.19	0.21	3.80	
0.18	0.20	3.77	1006.89

0.21	0.22	4.10	
0.20	0.21	3.96	
0.27	0.28	5.01	1005.02
0.26	0.26	4.79	
0.45	0.43	7.55	
0.33	0.32	5.80	1005.65
0.33	0.32	5.81	
0.20	0.22	4.07	
0.27	0.27	4.98	1006.21
0.28	0.28	5.14	
0.19	0.21	3.92	
0.94	0.94	14.35	1002.51
0.55	0.52	8.85	
0.56	0.54	9.10	
0.39	0.38	6.72	1004.15
0.44	0.43	7.42	
0.32	0.32	5.70	
0.39	0.38	6.65	
1.06	1.10	16.11	1003.26
0.34	0.33	5.93	
0.55	0.53	8.96	1003.23
0.72	0.69	11.29	
0.57	0.55	9.23	
0.34	0.33	5.92	1004.17
0.63	0.61	10.08	
0.37	0.36	6.40	
0.50	0.48	8.22	1002.78
0.46	0.44	7.65	
0.74	0.71	11.55	
0.73	0.70	11.35	1004.44
0.24	0.25	4.57	
0.26	0.26	4.79	
0.19	0.21	3.83	1006.02
0.26	0.27	4.89	
0.28	0.28	5.09	
0.33	0.33	5.87	1005.08
0.34	0.33	5.98	
0.33	0.33	5.87	
0.20	0.22	4.05	1006.77
0.20	0.21	3.97	
0.25	0.26	4.68	
0.17	0.19	3.52	1006.57
0.17	0.19	3.52	
0.24	0.25	4.50	
0.96	0.97	14.70	999.33

1.18	1.25	17.66	
0.32	0.32	5.67	
0.63	0.60	9.96	1003.02
0.43	0.41	7.17	
0.62	0.59	9.88	
0.25	0.26	4.75	1005.96
0.28	0.28	5.12	
0.25	0.26	4.75	
0.25	0.26	4.71	1006.68
0.23	0.24	4.47	
0.22	0.24	4.33	
0.37	0.36	6.38	1004.58
0.40	0.39	6.84	
0.39	0.38	6.64	1004.51
0.46	0.44	7.67	
0.23	0.24	4.45	1005.86
0.21	0.23	4.20	
0.27	0.27	4.97	
0.47	0.45	7.76	1004.43
0.42	0.40	7.10	
0.43	0.41	7.24	
0.45	0.43	7.49	1005.44
0.25	0.26	4.67	
0.36	0.35	6.31	
0.24	0.25	4.56	1006.24
0.18	0.20	3.79	
0.20	0.22	4.04	
0.28	0.29	5.18	1004.73
0.45	0.43	7.47	
0.47	0.45	7.83	
0.50	0.48	8.19	1003.59
0.53	0.51	8.68	
0.48	0.45	7.86	
0.56	0.54	9.11	1002.95
0.59	0.56	9.48	
0.55	0.52	8.83	
0.49	0.47	8.09	1003.07
0.56	0.53	9.01	
0.63	0.60	9.95	
0.26	0.27	4.87	1005.17
0.32	0.32	5.69	
0.34	0.34	5.99	
0.20	0.22	3.99	1006.04
0.41	0.39	6.94	
0.14	0.17	3.15	

0.58	0.55	9.27	1003.81
0.24	0.25	4.57	
0.37	0.36	6.39	
0.60	0.58	9.66	1003.97
0.21	0.23	4.16	
0.60	0.57	9.60	
0.36	0.35	6.28	1004.64
0.43	0.42	7.27	
0.45	0.43	7.51	
0.53	0.50	8.55	1003.76
0.42	0.40	7.05	
0.34	0.33	5.91	
0.37	0.36	6.33	1004.02
0.54	0.52	8.81	
0.57	0.55	9.23	
0.32	0.32	5.67	1004.50
0.30	0.30	5.42	
0.35	0.34	6.04	
0.76	0.73	11.77	1002.95
0.53	0.50	8.57	
0.40	0.39	6.81	
0.60	0.57	9.57	1003.11
0.57	0.55	9.22	
0.61	0.59	9.80	
0.40	0.39	6.79	1001.74
0.99	1.00	15.02	
1.01	1.02	15.33	
0.37	0.36	6.41	1004.40
0.30	0.30	5.41	
0.39	0.38	6.68	
0.31	0.31	5.53	1005.61
0.32	0.31	5.62	
0.32	0.32	5.67	
0.38	0.37	6.56	1004.77
0.38	0.37	6.53	
0.38	0.37	6.54	
1.16	1.23	17.46	999.45
1.18	1.25	17.75	
0.27	0.28	5.01	1006.04
0.26	0.27	4.91	
0.25	0.26	4.72	
0.63	0.60	10.03	1004.41
0.41	0.39	6.91	
0.36	0.35	6.26	
0.68	0.65	10.73	1001.89

0.61	0.58	9.72	
0.88	0.87	13.54	
0.66	0.63	10.47	1002.255
1.06	1.09	16.00	
0.60	0.57	9.56	1003.42
0.44	0.42	7.37	
0.56	0.53	9.04	
0.66	0.63	10.41	1002.49
0.66	0.63	10.37	
0.65	0.62	10.31	
0.56	0.54	9.08	1002.32
0.78	0.76	12.10	
0.55	0.52	8.85	
0.45	0.43	7.45	1004.92
0.41	0.39	6.89	
0.47	0.45	7.73	
0.37	0.36	6.40	1004.86
0.42	0.40	7.05	
0.47	0.44	7.72	
0.41	0.39	6.88	1004.49
0.45	0.43	7.45	
0.35	0.34	6.05	
0.57	0.54	9.16	1002.94
0.50	0.47	8.16	
0.71	0.68	11.09	
0.40	0.38	6.79	1004.97
0.42	0.40	7.07	
0.35	0.34	6.13	
0.50	0.48	8.23	1004.05
0.50	0.48	8.27	
0.48	0.45	7.86	
0.33	0.32	5.82	1004.70
0.36	0.35	6.19	
0.27	0.27	4.97	
0.53	0.50	8.59	1003.93
0.48	0.46	7.95	
0.55	0.52	8.86	
0.33	0.33	5.83	1005.01
0.46	0.44	7.65	
0.38	0.37	6.50	
0.55	0.52	8.89	1004.41
0.57	0.54	9.12	
0.56	0.53	9.01	
0.41	0.40	6.97	1004.88
0.37	0.36	6.39	

0.43	0.42	7.27	
0.43	0.42	7.29	1004.78
0.37	0.36	6.39	
0.45	0.43	7.54	
0.99	1.00	15.04	1000.34
0.66	0.63	10.47	
1.21	1.29	18.11	



<i>avg FWHM per $\delta^{18}\text{O}$ spot</i>	<i>avg Deff per $\delta^{18}\text{O}$ spot</i>
22.60	1.85
22.20	1.82
27.53	2.72
23.79	2.02
4.37	0.24
15.79	1.07
17.89	1.28
27.04	2.81
28.71	3.02
26.93	2.66
22.71	2.08

30.30	3.54
24.01	2.06
31.16	3.79
18.38	1.32
21.73	1.74
10.80	0.69
27.70	2.74
26.90	2.62
14.97	1.00
8.66	0.51
15.28	1.26
5.51	0.31
7.54	0.43
13.80	0.90
6.49	0.37

15.58	1.27
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5.03	0.28
-------------	-------------

7.60	0.44
-------------	-------------

6.32	0.36
-------------	-------------

5.14	0.28
-------------	-------------

4.58	0.25
-------------	-------------

5.03	0.28
-------------	-------------

5.85	0.33
-------------	-------------

5.09	0.28
-------------	-------------

5.09	0.28
-------------	-------------

13.96	0.95
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5.50	0.31
-------------	-------------

5.12	0.28
-------------	-------------

7.88	0.46
-------------	-------------

3.35	0.18
-------------	-------------

3.94	0.21
-------------	-------------

5.78	0.32
-------------	-------------

5.23	0.29
-------------	-------------

4.68	0.26
-------------	-------------

10.77	0.67
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6.62	0.37
-------------	-------------

11.02	0.71
--------------	-------------

9.83	0.59
-------------	-------------

7.47	0.43
-------------	-------------

9.14	0.54
-------------	-------------

6.90	0.40
-------------	-------------

4.60	0.25
-------------	-------------

5.91	0.33
-------------	-------------

4.23	0.23
-------------	-------------

3.85	0.21
-------------	-------------

12.68	0.84
--------------	-------------

9.00	0.53
-------------	-------------

4.87	0.27
-------------	-------------

4.50	0.25
-------------	-------------

6.61	0.37
-------------	-------------

7.15	0.41
-------------	-------------

4.54	0.25
-------------	-------------

7.36	0.42
-------------	-------------

6.16	0.35
-------------	-------------

4.13	0.22
-------------	-------------

6.83	0.39
-------------	-------------

8.24	0.48
-------------	-------------

9.14	0.54
-------------	-------------

9.02	0.53
-------------	-------------

5.51	0.31
-------------	-------------

4.70	0.26
-------------	-------------

6.74	0.39
7.81	0.46
7.02	0.40
7.17	0.41
8.12	0.47
5.71	0.32
9.05	0.54
9.53	0.57
12.38	0.80
6.17	0.35
5.61	0.31
6.54	0.37
17.60	1.24
4.88	0.27
7.73	0.45
11.33	0.70

13.24	0.86
8.66	0.51
10.36	0.63
10.01	0.60
7.35	0.42
7.06	0.40
6.79	0.39
9.47	0.56
6.67	0.38
8.12	0.47
5.66	0.32
8.47	0.49
6.66	0.38
9.01	0.53
6.88	0.39

7.07

0.40

14.54

0.97





Supplemental Table S3: WiscSIMS Oxygen Isotope Results Session 1

Comment	$\delta^{18}\text{O}$ ‰ VSMOW	2SD (ext.)	Mass Bias (‰)	$\delta^{18}\text{O}$ ‰ measured	2SE (int.)	^{16}O (Gcps)
WI-STD-94_UWZ1				4.899	0.119	2.81
WI-STD-94_UWZ1				4.915	0.132	2.84
WI-STD-94_UWZ1				4.687	0.200	2.83
WI-STD-94_UWZ1				4.872	0.212	2.83
Average and 2SD				4.843	0.212	
WI-STD-94_UWZ1				5.001	0.124	2.82
WI-STD-94_UWZ1				4.931	0.179	2.81
WI-STD-94_UWZ1				4.767	0.156	2.81
WI-STD-94_UWZ1				4.912	0.163	2.80
Average and 2SD				4.903	0.197	
Bracket Average and 2SD				4.873	0.199	
SG-127_UWZ1 g1-001				4.891	0.156	2.76
SG-127_UWZ1 g1-002				4.707	0.163	2.75
SG-127_UWZ1 g1-003				4.855	0.183	2.75
SG-127_UWZ1 g1-004				4.803	0.153	2.74
Average and 2SD				4.814	0.160	
SG-127-A01-3	6.61	0.24	-0.075	6.536	0.152	2.74
SG-127-A01-2	6.48	0.24	-0.075	6.400	0.192	2.74
SG-127-A01-1	6.50	0.24	-0.075	6.425	0.160	2.75
SG-127-B01-1	6.67	0.24	-0.075	6.595	0.208	2.74
SG-127-B01-2	6.86	0.24	-0.075	6.780	0.172	2.74
SG-127-B01-3	6.55	0.24	-0.075	6.478	0.191	2.72
SG-127-E01-1	6.20	0.24	-0.075	6.122	0.193	2.72
SG-127-E01-2	6.27	0.24	-0.075	6.195	0.194	2.71
SG-127-D04-1	6.95	0.24	-0.075	6.876	0.205	2.70
SG-127-D04-2	7.06	0.24	-0.075	6.981	0.202	2.64
SG-127_UWZ1 g1-005				5.043	0.195	2.63
SG-127_UWZ1 g1-006				5.065	0.193	2.64
SG-127_UWZ1 g1-007				4.982	0.182	2.64
SG-127_UWZ1 g1-008				4.888	0.142	2.63
Average and 2SD				4.994	0.159	
Bracket Average and 2SD	4.98		-0.075	4.904	0.242	
SG-127-D04-3 CsRes=107	6.63	0.21	-0.025	6.602	0.193	2.81
SG-127-D06-1	7.00	0.21	-0.025	6.974	0.167	2.85
SG-127-D06-2	7.19	0.21	-0.025	7.169	0.167	2.87
SG-127-D06-3	6.98	0.21	-0.025	6.956	0.225	2.87

SG-127-B11-1	6.72	0.21	-0.025	6.693	0.127	2.85
SG-127-B11-3	6.41	0.21	-0.025	6.387	0.200	2.84
SG-127-B16-1	6.10	0.21	-0.025	6.074	0.193	2.82
SG-127-B16-2	6.47	0.21	-0.025	6.444	0.181	2.80
SG-127-A16-1	6.99	0.21	-0.025	6.964	0.186	2.82
SG-127-A16-3	6.81	0.21	-0.025	6.784	0.198	2.79

SG-127_UWZ1 g1-009				5.084	0.205	2.76
SG-127_UWZ1 g1-010				4.908	0.178	2.75
SG-127_UWZ1 g1-011				4.793	0.157	2.75
SG-127_UWZ1 g1-012				4.880	0.160	2.74

Average and 2SD

Bracket Average and 2SD **4.98** **-0.025** **4.955** **0.208**

SG-127_UWZ1 g1-013				3.913	0.156	2.96
SG-127_UWZ1 g1-014				4.461	0.156	2.94
SG-127_UWZ1 g1-015				4.451	0.182	2.93
SG-127_UWZ1 g1-016				4.642	0.169	2.91
SG-127_UWZ1 g1-017				4.535	0.151	2.91

Average and 2SD

4.522 **0.176**

SG-027_UWZ1 g1-001				4.829	0.238	2.84
SG-027_UWZ1 g1-002				4.834	0.175	2.82
SG-027_UWZ1 g1-003				4.727	0.163	2.82
SG-027_UWZ1 g1-004				4.844	0.173	2.81

Average and 2SD

4.809 **0.109**

SG-027-B14-1	8.06	0.30	-0.049	8.007	0.165	2.81
SG-027-B14-2	8.06	0.30	-0.049	8.011	0.193	2.80
SG-027-B14-3	7.82	0.30	-0.049	7.770	0.189	2.81
SG-027-C15-1	8.39	0.30	-0.049	8.339	0.153	2.77
SG-027-C15-2	7.93	0.30	-0.049	7.880	0.160	2.75
SG-027-C15-3	7.83	0.30	-0.049	7.785	0.162	2.76
SG-027-D17-1	8.36	0.30	-0.049	8.307	0.140	2.75
SG-027-D17-2	7.97	0.30	-0.049	7.917	0.175	2.75
SG-027-D17-3	8.07	0.30	-0.049	8.022	0.242	2.73
SG-027-D13-1	8.27	0.30	-0.049	8.222	0.148	2.73
SG-027-D13-2	8.20	0.30	-0.049	8.151	0.169	2.71
SG-027-D07-1	8.21	0.30	-0.049	8.157	0.190	2.66

SG-027_UWZ1 g1-005				5.180	0.145	2.61
SG-027_UWZ1 g1-006 CsRes=108				4.964	0.177	2.79
SG-027_UWZ1 g1-007				5.050	0.164	2.81
SG-027_UWZ1 g1-008				5.014	0.164	2.81

Average and 2SD				5.052	0.185	
Bracket Average and 2SD	4.98		-0.049	4.930	0.296	
SG-027-D07-2	8.16	0.15	0.072	8.230	0.210	2.84
SG-027-E04-1	8.03	0.15	0.072	8.099	0.108	2.87
SG-027-E04-2	7.91	0.15	0.072	7.985	0.151	2.85
SG-027-E04-3	7.97	0.15	0.072	8.046	0.169	2.82
SG-027-E11-01	8.10	0.15	0.072	8.175	0.209	2.85
SG-027-E11-02	8.29	0.15	0.072	8.363	0.169	2.82
SG-027-F10-1	8.36	0.15	0.072	8.431	0.190	2.81
SG-027-F10-2	8.04	0.15	0.072	8.111	0.199	2.83
SG-027-F10-3	8.20	0.15	0.072	8.269	0.202	2.81
SG-027-F10-4	8.25	0.15	0.072	8.318	0.174	2.80
SG-027-F15-1	8.35	0.15	0.072	8.426	0.215	2.82
SG-027-F15-2	8.84	0.15	0.072	8.916	0.170	2.82
SG-027_UWZ1 g1-009				5.161	0.185	2.74
SG-027_UWZ1 g1-010				5.024	0.201	2.75
SG-027_UWZ1 g1-011				5.027	0.186	2.74
SG-027_UWZ1 g1-012				5.001	0.159	2.76
Average and 2SD				5.053	0.145	
Bracket Average and 2SD	4.98		0.072	5.053	0.154	
SG-210c_UWZ1 g1-001				4.961	0.162	2.72
SG-210c_UWZ1 g1-002				4.841	0.169	2.71
SG-210c_UWZ1 g1-003				4.969	0.141	2.70
SG-210c_UWZ1 g1-004				4.995	0.212	2.69
Average and 2SD				4.941	0.137	
SG-210c-A01-1	5.34	0.14	-0.085	5.257	0.179	2.68
SG-210c-A01-2	5.97	0.14	-0.085	5.885	0.176	2.68
SG-210c-A01-3	5.35	0.14	-0.085	5.267	0.203	2.68
SG-210c-A15-1	5.62	0.14	-0.085	5.540	0.211	2.67
SG-210c-A15-2	5.71	0.14	-0.085	5.625	0.213	2.67
SG-210c-A15-3	5.10	0.14	-0.085	5.010	0.165	2.66
SG-210c-A15-4	5.63	0.14	-0.085	5.541	0.128	2.65
SG-210c-B15-1	5.63	0.14	-0.085	5.545	0.131	2.66
SG-210c-B15-2	5.51	0.14	-0.085	5.424	0.156	2.66
SG-210c-B17-1	5.57	0.14	-0.085	5.486	0.191	2.65
SG-210c-B17-2 CsRes=109	5.60	0.14	-0.085	5.517	0.198	2.83
SG-210c-C06-1	5.41	0.14	-0.085	5.330	0.141	2.85
SG-210c_UWZ1 g1-005				4.812	0.235	2.85
SG-210c_UWZ1 g1-006				4.901	0.187	2.87

SG-210c_UWZ1 g1-007				4.849	0.148	2.84
SG-210c_UWZ1 g1-008				4.830	0.168	2.81
Average and 2SD				4.848	0.077	
Bracket Average and 2SD	4.98	-0.085		4.895	0.143	
SG-210c-C06-2	5.35	0.18	-0.080	5.271	0.164	2.84
SG-210c-C08-1	6.03	0.18	-0.080	5.954	0.164	2.85
SG-210c-C08-2	5.18	0.18	-0.080	5.098	0.129	2.84
SG-210c-C10-1	5.72	0.18	-0.080	5.638	0.176	2.84
SG-210c-C10-2	5.97	0.18	-0.080	5.892	0.184	2.83
SG-210c-D08-1	5.24	0.18	-0.080	5.157	0.158	2.81
SG-210c-D08-2	5.69	0.18	-0.080	5.612	0.160	2.81
SG-210c-D08-3	5.59	0.18	-0.080	5.506	0.180	2.80
SG-210c-D10-1	5.12	0.18	-0.080	5.035	0.156	2.80
SG-210c-D10-2	5.51	0.18	-0.080	5.428	0.169	2.79
SG-210c-D10-3	5.72	0.18	-0.080	5.642	0.167	2.77
SG-210c-D11-1	5.45	0.18	-0.080	5.368	0.124	2.77
SG-210c-D11-2	5.50	0.18	-0.080	5.416	0.132	2.77
SG-210c-D11-3	5.48	0.18	-0.080	5.399	0.174	2.75
SG-210c_UWZ1 g1-009				5.053	0.219	2.73
SG-210c_UWZ1 g1-010				4.829	0.194	2.72
SG-210c_UWZ1 g1-011				5.001	0.178	2.71
SG-210c_UWZ1 g1-012				4.924	0.157	2.69
Average and 2SD				4.952	0.195	
Bracket Average and 2SD	4.98	-0.080		4.900	0.176	
SG-210c-D17-1	5.43	0.29	0.050	5.477	0.195	2.73
SG-210c-D17-2	5.57	0.29	0.050	5.615	0.121	2.72
SG-210c-D17-3	5.39	0.29	0.050	5.440	0.219	2.72
SG-210c-E17-1	5.36	0.29	0.050	5.413	0.147	2.72
SG-210c-E17-2	6.03	0.29	0.050	6.080	0.181	2.72
SG-210c-F01-1	5.38	0.29	0.050	5.435	0.221	2.71
SG-210c-F01-2	5.41	0.29	0.050	5.458	0.239	2.69
SG-210c-F05-1	5.28	0.29	0.050	5.330	0.195	2.69
SG-210c-F05-2	5.50	0.29	0.050	5.555	0.150	2.69
SG-210c-F09-1	5.56	0.29	0.050	5.614	0.181	2.67
SG-210c-F09-2	5.53	0.29	0.050	5.579	0.180	2.66
SG-210c-F09-3	5.03	0.29	0.050	5.084	0.200	2.66
SG-210c_UWZ1 g1-013				5.051	0.169	2.62
SG-210c_UWZ1 g1-014				4.931	0.197	2.66
SG-210c_UWZ1 g1-015				5.295	0.162	2.63
SG-210c_UWZ1 g1-016				5.153	0.163	2.62
Average and 2SD				5.108	0.309	

Bracket Average and 2SD	4.98		0.050	5.030	0.291	
SG-210c-F10-01 CsRes=110	5.37	0.31	0.021	5.392	0.225	2.84
SG-210c-F10-02	5.28	0.31	0.021	5.296	0.131	2.85
SG-210c-F10-03	5.23	0.31	0.021	5.254	0.146	2.84
SG-210c-F10-04	5.07	0.31	0.021	5.094	0.140	2.86
SG-210c-F13-1	5.31	0.31	0.021	5.330	0.204	2.86
SG-210c-F13-2	5.32	0.31	0.021	5.336	0.222	2.85
SG-210c-F13-3	5.33	0.31	0.021	5.355	0.182	2.84
SG-210c-F13-4	5.47	0.31	0.021	5.493	0.151	2.85
SG-210c-F14-1	5.37	0.31	0.021	5.392	0.129	2.84
SG-210c-F14-2	5.22	0.31	0.021	5.242	0.157	2.83
SG-210c-F14-3	5.29	0.31	0.021	5.313	0.177	2.83
SG-210c-F14-4	5.40	0.31	0.021	5.419	0.138	2.82
SG-210c_UWZ1 g1-017				4.926	0.179	2.81
SG-210c_UWZ1 g1-018				4.847	0.211	2.80
SG-210c_UWZ1 g1-019				4.949	0.168	2.80
SG-210c_UWZ1 g1-020				4.855	0.209	2.79
Average and 2SD				4.894	0.102	
Bracket Average and 2SD	4.98		0.021	5.001	0.312	
SG-122_UWZ1 g1-001				4.686	0.169	2.76
SG-122_UWZ1 g1-002				4.961	0.163	2.75
SG-122_UWZ1 g1-003				4.892	0.133	2.73
SG-122_UWZ1 g1-004				5.061	0.157	2.73
Average and 2SD				4.900	0.318	
SG-122-A17-1	5.23	0.24	-0.050	5.184	0.202	2.77
SG-122-A17-2	5.41	0.24	-0.050	5.363	0.154	2.75
SG-122-A17-3	5.37	0.24	-0.050	5.320	0.193	2.74
SG-122-B01-1	6.24	0.24	-0.050	6.185	0.216	2.76
SG-122-B01-2	6.49	0.24	-0.050	6.440	0.148	2.75
SG-122-B02-1	5.68	0.24	-0.050	5.629	0.197	2.71
SG-122-B02-2	5.70	0.24	-0.050	5.654	0.149	2.70
SG-122-B02-3	5.44	0.24	-0.050	5.392	0.149	2.70
SG-122-B04-1	5.62	0.24	-0.050	5.568	0.179	2.68
SG-122-B04-2	5.61	0.24	-0.050	5.556	0.167	2.69
SG-122-B12-1	5.64	0.24	-0.050	5.585	0.164	2.69
SG-122-B12-2	5.58	0.24	-0.050	5.528	0.142	2.68
SG-122-B12-3	5.49	0.24	-0.050	5.436	0.206	2.67
SG-122_UWZ1 g1-005				4.967	0.127	2.64
SG-122_UWZ1 g1-006				4.965	0.164	2.61

SG-122_UWZ1 g1-007 CsRes=111				5.044	0.139	2.79
SG-122_UWZ1 g1-008				4.863	0.209	2.82
Average and 2SD				4.960	0.149	
Bracket Average and 2SD	4.98	-0.050		4.930	0.238	
SG-122-C01-1	7.26	0.22	-0.093	7.164	0.191	2.87
SG-122-C01-2	7.07	0.22	-0.093	6.978	0.151	2.86
SG-122-C01-3	8.75	0.22	-0.093	8.658	0.185	2.85
SG-122-C12-1	5.65	0.22	-0.093	5.558	0.163	2.84
SG-122-C12-2	5.87	0.22	-0.093	5.772	0.127	2.83
SG-122-C12-3	5.56	0.22	-0.093	5.470	0.177	2.85
SG-122-C15-1	5.78	0.22	-0.093	5.690	0.156	2.84
SG-122-C15-2	5.83	0.22	-0.093	5.732	0.170	2.82
SG-122-C15-3	5.59	0.22	-0.093	5.501	0.172	2.82
SG-122-C15-4	5.07	0.22	-0.093	4.979	0.153	2.84
SG-122-C17-1	5.58	0.22	-0.093	5.491	0.175	2.79
SG-122-C17-2	6.02	0.22	-0.093	5.924	0.157	2.83
SG-122-C17-3	6.23	0.22	-0.093	6.135	0.183	2.83
SG-122_UWZ1 g1-009				4.691	0.175	2.83
SG-122_UWZ1 g1-010				4.886	0.147	2.81
SG-122_UWZ1 g1-011				4.851	0.172	2.80
SG-122_UWZ1 g1-012				4.827	0.178	2.81
Average and 2SD				4.814	0.171	
Bracket Average and 2SD	4.98	-0.093		4.887	0.215	
SG-122-C18-1	5.76	0.14	-0.141	5.617	0.209	2.82
SG-122-C18-2	6.02	0.14	-0.141	5.881	0.112	2.82
SG-122-C18-3	6.37	0.14	-0.141	6.224	0.185	2.82
SG-122-C18-4	6.21	0.14	-0.141	6.069	0.187	2.81
SG-122-C21-1	5.36	0.14	-0.141	5.218	0.146	2.80
SG-122-C21-2	5.97	0.14	-0.141	5.830	0.215	2.79
SG-122-D02-1	5.57	0.14	-0.141	5.433	0.175	2.83
SG-122-D02-2	5.73	0.14	-0.141	5.583	0.184	2.79
SG-122-D06-1	5.80	0.14	-0.141	5.654	0.172	2.79
SG-122-D06-2	5.81	0.14	-0.141	5.670	0.147	2.76
SG-122-E01-1	5.88	0.14	-0.141	5.740	0.116	2.73
SG-122-E01-2	5.62	0.14	-0.141	5.477	0.175	2.72
SG-122-E02-1	6.39	0.14	-0.141	6.247	0.188	2.71
SG-122-E02-2	5.97	0.14	-0.141	5.830	0.152	2.71
SG-122-E05-1	5.75	0.14	-0.141	5.605	0.129	2.69
SG-122-E05-2	5.74	0.14	-0.141	5.602	0.210	2.66
SG-122_UWZ1 g1-013				4.791	0.110	2.66
SG-122_UWZ1 g1-014				4.866	0.150	2.63

SG-122_UWZ1 g1-015				4.927	0.185	2.64
SG-122_UWZ1 g1-016 CsRes=112				4.870	0.167	2.81
Average and 2SD				4.863	0.111	
Bracket Average and 2SD	4.98	-0.141		4.838	0.144	

SG-026_UWZ1 g1-001				4.889	0.195	2.76
SG-026_UWZ1 g1-002				4.733	0.191	2.77
SG-026_UWZ1 g1-003				4.854	0.166	2.75
SG-026_UWZ1 g1-004				4.864	0.213	2.76
Average and 2SD				4.835	0.139	

SG-026-A03-1	6.42	0.10	0.029	6.453	0.177	2.75
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SG-026_UWZ1 g1-001b				5.004	0.170	2.73
SG-026_UWZ1 g1-002b				4.956	0.170	2.72
SG-026_UWZ1 g1-003b				5.060	0.163	2.72
SG-026_UWZ1 g1-004b				4.952	0.185	2.71
Average and 2SD				4.993	0.101	

SG-026-A03-2	6.59	0.10	0.029	6.618	0.256	2.69
SG-026-A03-3	6.44	0.10	0.029	6.474	0.160	2.68
SG-026-A03-4	6.58	0.10	0.029	6.611	0.142	2.68
SG-026-A04-1	6.55	0.10	0.029	6.577	0.176	2.67
SG-026-A04-2	6.71	0.10	0.029	6.739	0.184	2.65
SG-026-A04-3 CsRes=113	6.58	0.10	0.029	6.610	0.213	2.83
SG-026-A04-4	5.97	0.10	0.029	5.999	0.195	2.88
SG-026-A07-1	6.55	0.10	0.029	6.578	0.168	2.87
SG-026-A07-2	6.43	0.10	0.029	6.459	0.186	2.87
SG-026-A07-3	6.49	0.10	0.029	6.515	0.143	2.85
SG-026-A13-1	6.50	0.10	0.029	6.529	0.179	2.85
SG-026-A13-2	6.42	0.10	0.029	6.449	0.148	2.83
SG-026-A13-3	6.20	0.10	0.029	6.233	0.174	2.82
SG-026-B12-1	6.33	0.10	0.029	6.363	0.191	2.82
SG-026-B12-2	6.30	0.10	0.029	6.334	0.159	2.81

SG-026_UWZ1 g1-005				4.955	0.170	2.78
SG-026_UWZ1 g1-006				5.014	0.141	2.78
SG-026_UWZ1 g1-007				5.064	0.176	2.78
SG-026_UWZ1 g1-008				5.067	0.152	2.75
Average and 2SD				5.025	0.105	
Bracket Average and 2SD	4.98	0.02881		5.009	0.101	

SG-026-B12-3	6.39	0.15	0.053	6.439	0.197	2.77
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SG-026-B14-1	6.37	0.15	0.053	6.428	0.164	2.76
SG-026-B14-2	6.32	0.15	0.053	6.372	0.119	2.75
SG-026-B14-3	6.33	0.15	0.053	6.382	0.191	2.75
SG-026-C15-1	6.34	0.15	0.053	6.396	0.189	2.75
SG-026-C15-2	6.25	0.15	0.053	6.303	0.183	2.74
SG-026-C15-3	6.38	0.15	0.053	6.428	0.187	2.73
SG-026-C16-1	6.76	0.15	0.053	6.810	0.206	2.72
SG-026-C16-2	6.64	0.15	0.053	6.693	0.168	2.71
SG-026-C16-3	6.33	0.15	0.053	6.382	0.208	2.69
SG-026-D04-1	6.34	0.15	0.053	6.397	0.127	2.72
SG-026-D04-2	6.43	0.15	0.053	6.482	0.191	2.73
SG-026-D13-1	6.51	0.15	0.053	6.568	0.144	2.71
SG-026-D13-2	6.23	0.15	0.053	6.287	0.176	2.69
SG-026-D13-2	6.27	0.15	0.053	6.321	0.179	2.69
SG-026-D17-2	6.23	0.15	0.053	6.284	0.180	2.67

SG-026_UWZ1 g1-009				4.965	0.143	2.64
SG-026_UWZ1 g1-010				5.026	0.207	2.65
SG-026_UWZ1 g1-011				4.988	0.199	2.64
SG-026_UWZ1 g1-012				5.184	0.189	2.63

Average and 2SD				5.041	0.197	
Bracket Average and 2SD	4.98		0.05251	5.033	0.147	

SG-026-D17-3	6.28	0.29	-0.020	6.255	0.172	2.63
SG-026-D17-4	6.44	0.29	-0.020	6.418	0.161	2.63
SG-026-E03-1 CsRes=114	6.50	0.29	-0.020	6.475	0.211	2.83
SG-026-E03-2	6.48	0.29	-0.020	6.458	0.168	2.86
SG-026-E04-1	6.29	0.29	-0.020	6.272	0.199	2.88
SG-026-E04-2	6.35	0.29	-0.020	6.332	0.165	2.87
SG-026-E04-3	6.49	0.29	-0.020	6.466	0.182	2.89
SG-026-F02-1	6.44	0.29	-0.020	6.418	0.178	2.85
SG-026-F02-2	6.62	0.29	-0.020	6.598	0.145	2.86
SG-026-F02-3	6.33	0.29	-0.020	6.310	0.173	2.85
SG-026-F05-1	6.42	0.29	-0.020	6.402	0.187	2.86
SG-026-F05-2	6.41	0.29	-0.020	6.390	0.150	2.84
SG-026-F05-3	5.49	0.29	-0.020	5.468	0.146	2.84
SG-026-F09-1	6.53	0.29	-0.020	6.506	0.226	2.82
SG-026-F09-2	6.38	0.29	-0.020	6.361	0.178	2.80
SG-026-F09-3	6.31	0.29	-0.020	6.286	0.178	2.80

SG-026_UWZ1 g1-013				5.103	0.187	2.77
SG-026_UWZ1 g1-014				4.799	0.117	2.76
SG-026_UWZ1 g1-015				4.766	0.192	2.75
SG-026_UWZ1 g1-016				4.848	0.259	2.73

Average and 2SD				4.879	0.306	
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Bracket Average and 2SD	4.98	-0.02001	4.960	0.294		
SG-026-F09-4	6.25	0.27	-0.050	6.196	0.201	2.76
SG-026-F11-1	6.54	0.27	-0.050	6.492	0.176	2.75
SG-026-F11-2	6.12	0.27	-0.050	6.071	0.226	2.75
SG-026-F11-3	6.58	0.27	-0.050	6.533	0.171	2.75
SG-026-F14-1	6.48	0.27	-0.050	6.429	0.202	2.75
SG-026-F14-1	6.50	0.27	-0.050	6.454	0.201	2.74
SG-026-F14-3	5.28	0.27	-0.050	5.234	0.179	2.72
SG-026-F14-4	6.46	0.27	-0.050	6.408	0.182	2.75
SG-026-F15-1	6.43	0.27	-0.050	6.378	0.194	2.72
SG-026-F15-2	6.44	0.27	-0.050	6.394	0.170	2.71
SG-026-F15-3	6.50	0.27	-0.050	6.450	0.164	2.70
SG-026-F18-1	6.08	0.27	-0.050	6.028	0.159	2.71
SG-026-F18-2	6.53	0.27	-0.050	6.483	0.233	2.69
SG-026-F18-3	6.40	0.27	-0.050	6.346	0.208	2.69
SG-026_UWZ1 g1-017				5.013	0.176	2.68
SG-026_UWZ1 g1-018				5.111	0.190	2.68
SG-026_UWZ1 g1-019				4.970	0.162	2.65
SG-026_UWZ1 g1-020				4.828	0.165	2.65
Average and 2SD				4.981	0.235	
Bracket Average and 2SD	4.98	-0.04989		4.930	0.275	
SG-203_UWZ1g1-001 CsRes=115				4.592	0.146	2.77
SG-203_UWZ1g1-002				4.790	0.370	2.77
SG-203_UWZ1g1-003				4.750	0.129	2.76
SG-203_UWZ1g1-004				4.622	0.151	2.76
Average and 2SD				4.688	0.193	
SG-203-A02-1	7.63	0.16	-0.249	7.379	0.152	2.73
SG-203-A02-2	7.85	0.16	-0.249	7.601	0.136	2.73
SG-203-A02-3	7.54	0.16	-0.249	7.287	0.202	2.72
SG-203-A03-1	7.79	0.16	-0.249	7.534	0.188	2.70
SG-203-A03-2	7.90	0.16	-0.249	7.645	0.203	2.71
SG-203-A04-1	6.11	0.16	-0.249	5.861	0.180	2.79
SG-203-A04-2	7.50	0.16	-0.249	7.244	0.177	2.66
SG-203-A04-3	8.02	0.16	-0.249	7.769	0.192	2.67
SG-203-A04-4	7.54	0.16	-0.249	7.293	0.153	2.67
SG-203-A06-1	7.93	0.16	-0.249	7.683	0.179	2.65
SG-203-A06-2	8.01	0.16	-0.249	7.762	0.162	2.65
SG-203-A06-3	7.77	0.16	-0.249	7.517	0.174	2.64
SG-203-A07-1	7.99	0.16	-0.249	7.741	0.185	2.63
SG-203-A07-2	8.10	0.16	-0.249	7.848	0.201	2.62

SG-203-A07-3 CsRes=116	8.17	0.16	-0.249	7.916	0.190	2.76
SG-203-A12-1	7.74	0.16	-0.249	7.488	0.205	2.82
SG-203-A12-2	7.56	0.16	-0.249	7.306	0.186	2.82

SG-203_UWZ1g1-005				4.778	0.185	2.82
SG-203_UWZ1g1-006				4.716	0.161	2.81
SG-203_UWZ1g1-007				4.819	0.205	2.79
SG-203_UWZ1g1-008				4.769	0.174	2.78
Average and 2SD				4.770	0.085	
Bracket Average and 2SD	4.98		-0.24931	4.729	0.163	

SG-203-A12-3	8.04	0.33	-0.117	7.921	0.202	2.74
SG-203-A13-1	7.63	0.33	-0.117	7.508	0.213	2.75
SG-203-A13-2	7.18	0.33	-0.117	7.065	0.195	2.76
SG-203-B11-1	7.44	0.33	-0.117	7.318	0.166	2.74
SG-203-B11-2	7.69	0.33	-0.117	7.572	0.173	2.74
SG-203-B11-3	7.72	0.33	-0.117	7.606	0.236	2.74
SG-203-B12-1	7.72	0.33	-0.117	7.606	0.163	2.72
SG-203-B12-2	7.66	0.33	-0.117	7.540	0.171	2.71
SG-203-B12-3	7.56	0.33	-0.117	7.446	0.179	2.72
SG-203-B18-1	7.62	0.33	-0.117	7.504	0.197	2.71
SG-203-B18-2	7.68	0.33	-0.117	7.559	0.161	2.70
SG-203-B18-3	7.48	0.33	-0.117	7.359	0.174	2.71
SG-203-C17-1	7.72	0.33	-0.117	7.598	0.229	2.69
SG-203-C17-2	7.75	0.33	-0.117	7.631	0.133	2.69
SG-203-D02-1	7.39	0.33	-0.117	7.272	0.119	2.66
SG-203-D02-2	7.89	0.33	-0.117	7.770	0.165	2.66

SG-203_UWZ1g1-009				5.135	0.188	2.68
SG-203_UWZ1g1-010				4.885	0.160	2.67
SG-203_UWZ1g1-011				5.092	0.187	2.67
SG-203_UWZ1g1-012				4.705	0.201	2.65
Average and 2SD				4.954	0.398	
Bracket Average and 2SD	4.98		-0.11711	4.862	0.331	

SG-203-D02-3	7.57	0.38	-0.147	7.421	0.139	2.65
SG-203-D07-1	6.90	0.38	-0.147	6.749	0.151	2.60
SG-203-D07-2	8.04	0.38	-0.147	7.887	0.135	2.65
SG-203-D07-3	7.51	0.38	-0.147	7.359	0.198	2.64
SG-203-D12-1	8.12	0.38	-0.147	7.971	0.130	2.63
SG-203-D12-2	7.82	0.38	-0.147	7.668	0.140	2.75
SG-203-D12-3	7.28	0.38	-0.147	7.130	0.188	2.79
SG-203-E15-1	7.65	0.38	-0.147	7.506	0.175	2.81
SG-203-E15-2	7.83	0.38	-0.147	7.677	0.151	2.81
SG-203-E15-3	7.80	0.38	-0.147	7.655	0.143	2.79

SG-203-F08-1	6.13	0.38	-0.147	5.985	0.176	2.85
SG-203-F08-2	7.60	0.38	-0.147	7.448	0.180	2.80
SG-203-F08-3	7.61	0.38	-0.147	7.462	0.175	2.78
SG-203-F08-4	7.62	0.38	-0.147	7.470	0.174	2.78
SG-203_UWZ1g1-013				4.634	0.139	2.76
SG-203_UWZ1g1-014				4.735	0.255	2.77
SG-203_UWZ1g1-015				4.749	0.157	2.75
SG-203_UWZ1g1-016				4.721	0.211	2.73
Average and 2SD				4.710	0.104	
Bracket Average and 2SD	4.98		-0.14735	4.832	0.375	

IP (nA)	Yield (Gcps/nA)	Date	Time	X	Y	DTFA-X	DTFA-Y	Mass
1.80	1.56	6/15/22	14:45	-1057	2478	2	5	899373
1.83	1.55	6/15/22	14:49	-2147	178	1	4	899373
1.83	1.55	6/15/22	14:52	-1057	2428	2	3	899373
1.83	1.55	6/15/22	14:55	-1057	2403	1	4	899373
	1.55							
1.82	1.55	6/15/22	15:00	-780	2536	0	5	899373
1.81	1.55	6/15/22	15:03	-805	2511	0	5	899373
1.81	1.55	6/15/22	15:06	-775	2486	0	5	899373
1.81	1.55	6/15/22	15:09	-770	2451	0	5	899373
	1.55							
	1.55							
1.80	1.53	6/15/22	15:58	-318	1645	5	18	899373
1.79	1.54	6/15/22	16:01	-293	1645	5	17	899373
1.79	1.54	6/15/22	16:04	-268	1645	4	17	899373
1.79	1.54	6/15/22	16:07	-243	1645	4	17	899373
	1.54							
1.78	1.53	6/15/22	16:15	-1883	-645	3	18	899373
1.78	1.54	6/15/22	16:18	-1942	-688	1	17	899373
1.78	1.55	6/15/22	16:22	-1926	-713	2	17	899373
1.77	1.55	6/15/22	16:26	-2164	-1247	2	13	899373
1.77	1.55	6/15/22	16:30	-2105	-1212	1	13	899373
1.76	1.55	6/15/22	16:33	-2053	-1124	2	13	899373
1.75	1.55	6/15/22	16:38	-1987	-2628	-2	12	899373
1.75	1.55	6/15/22	16:42	-1940	-2659	-2	12	899373
1.74	1.55	6/15/22	16:46	-785	-1999	-2	13	899373
1.73	1.52	6/15/22	16:54	-874	-1979	1	13	899373
1.72	1.53	6/15/22	16:58	-318	1620	3	18	899373
1.72	1.54	6/15/22	17:01	-293	1620	3	17	899373
1.71	1.54	6/15/22	17:04	-268	1620	3	17	899373
1.71	1.54	6/15/22	17:07	-243	1620	3	17	899373
	1.54							
	1.54							
1.81	1.56	6/15/22	17:12	-820	-1945	-1	12	899373
1.83	1.56	6/15/22	17:15	120	-1816	-5	13	899373
1.84	1.56	6/15/22	17:18	141	-1797	-7	13	899373
1.85	1.55	6/15/22	17:21	152	-1777	-5	13	899373

1.83	1.56	6/15/22	17:30	2042	-437	-6	14	899373
1.82	1.56	6/15/22	17:32	2016	-377	-6	15	899373
1.82	1.55	6/15/22	17:35	3961	171	-7	14	899373
1.82	1.54	6/15/22	17:38	3959	204	-7	13	899373
1.81	1.56	6/15/22	17:41	4175	687	-6	15	899373
1.81	1.54	6/15/22	17:44	4185	638	-6	15	899373

1.80	1.53	6/15/22	17:48	-318	1595	2	17	899373
1.80	1.53	6/15/22	17:51	-293	1595	3	17	899373
1.79	1.54	6/15/22	17:54	-268	1595	3	17	899373
1.79	1.53	6/15/22	17:56	-243	1595	3	17	899373

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1.93	1.53	6/16/22	7:54	-218	1595	9	25	899373
1.92	1.53	6/16/22	8:11	-168	1595	4	21	899381
1.91	1.53	6/16/22	8:14	-143	1595	4	21	899381
1.91	1.52	6/16/22	8:17	-118	1595	3	22	899381
1.90	1.53	6/16/22	8:20	-93	1595	3	21	899381

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1.83	1.55	6/16/22	8:39	-874	-2276	21	1	899381
1.82	1.55	6/16/22	8:42	-849	-2276	21	0	899381
1.81	1.56	6/16/22	8:45	-824	-2276	20	0	899381
1.81	1.55	6/16/22	8:48	-799	-2276	20	0	899381

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1.80	1.56	6/16/22	8:56	3724	1916	18	7	899381
1.81	1.55	6/16/22	8:59	3682	1905	18	7	899381
1.80	1.57	6/16/22	9:03	3789	1824	17	6	899381
1.79	1.55	6/16/22	9:07	4567	1236	12	7	899381
1.79	1.54	6/16/22	9:10	4597	1319	11	6	899381
1.78	1.56	6/16/22	9:14	4697	1076	12	5	899381
1.77	1.56	6/16/22	9:18	4637	461	12	5	899381
1.77	1.55	6/16/22	9:21	4576	628	11	5	899381
1.77	1.54	6/16/22	9:25	4486	681	13	4	899381
1.76	1.55	6/16/22	9:28	3033	718	20	3	899381
1.75	1.55	6/16/22	9:32	2973	757	21	3	899381
1.74	1.53	6/16/22	9:36	884	924	31	2	899381

1.69	1.54	6/16/22	9:43	-871	-2303	25	-2	899381
1.80	1.55	6/16/22	9:47	-846	-2303	24	-2	899381
1.82	1.54	6/16/22	9:50	-821	-2303	24	-2	899381
1.83	1.53	6/16/22	9:53	-796	-2303	24	-3	899381

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1.83	1.55	6/16/22	10:00	863	936	18	3	899381
1.83	1.57	6/16/22	10:05	-219	105	22	1	899381
1.82	1.57	6/16/22	10:08	-220	31	22	2	899381
1.81	1.55	6/16/22	10:12	-219	183	23	1	899381
1.80	1.58	6/16/22	10:17	2035	154	13	2	899381
1.79	1.57	6/16/22	10:20	1872	294	13	1	899381
1.80	1.56	6/16/22	10:24	1882	-793	13	1	899381
1.80	1.58	6/16/22	10:28	1864	-752	13	1	899381
1.80	1.57	6/16/22	10:31	1904	-714	13	1	899381
1.80	1.56	6/16/22	10:35	1991	-780	12	1	899381
1.79	1.57	6/16/22	10:39	3836	-655	3	3	899381
1.79	1.58	6/16/22	10:43	3736	-625	3	2	899381

1.78	1.54	6/16/22	10:50	-871	-2328	24	-2	899381
1.78	1.54	6/16/22	10:53	-846	-2328	24	-2	899381
1.78	1.54	6/16/22	10:56	-821	-2328	23	-2	899381
1.78	1.55	6/16/22	10:59	-796	-2328	23	-2	899381

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1.76	1.55	6/16/22	11:17	-312	1158	5	0	899381
1.75	1.54	6/16/22	11:20	-287	1158	5	-1	899381
1.75	1.54	6/16/22	11:23	-262	1158	5	-2	899381
1.75	1.54	6/16/22	11:26	-237	1158	4	-1	899381

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1.75	1.53	6/16/22	11:32	-3910	-1220	-1	4	899381
1.74	1.54	6/16/22	11:35	-3868	-1258	-1	3	899381
1.74	1.54	6/16/22	11:39	-3857	-1110	-1	3	899381
1.73	1.54	6/16/22	11:44	1953	-358	6	0	899381
1.72	1.55	6/16/22	11:48	1903	-369	5	1	899381
1.72	1.55	6/16/22	11:51	1929	-650	6	1	899381
1.72	1.54	6/16/22	11:55	1924	-578	6	1	899381
1.72	1.55	6/16/22	11:59	1945	-1186	5	1	899381
1.72	1.54	6/16/22	12:02	1973	-1210	5	1	899381
1.71	1.55	6/16/22	12:06	2776	-1085	7	0	899381
1.81	1.57	6/16/22	12:12	2710	-1137	6	0	899381
1.85	1.54	6/16/22	12:16	-1875	-2369	3	4	899381

1.86	1.54	6/16/22	12:21	-312	1133	5	-1	899381
1.86	1.54	6/16/22	12:24	-287	1133	4	-2	899381

1.86	1.53	6/16/22	12:27	-262	1133	4	-2	899381
1.86	1.52	6/16/22	12:30	-237	1133	4	-2	899381

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1.86	1.53	6/16/22	12:34	-1905	-2322	2	4	899381
1.85	1.54	6/16/22	12:37	-1199	-2391	3	4	899381
1.84	1.54	6/16/22	12:41	-1228	-2323	3	4	899381
1.84	1.55	6/16/22	12:45	-529	-2190	4	3	899381
1.83	1.54	6/16/22	12:48	-562	-2162	4	4	899381
1.83	1.54	6/16/22	12:53	-1648	-3094	2	5	899381
1.83	1.53	6/16/22	12:56	-1589	-3055	3	5	899381
1.82	1.53	6/16/22	13:00	-1599	-3131	2	6	899381
1.82	1.54	6/16/22	13:04	-977	-2938	3	4	899381
1.81	1.54	6/16/22	13:07	-926	-2954	3	5	899381
1.80	1.54	6/16/22	13:11	-956	-2984	3	5	899381
1.80	1.54	6/16/22	13:15	-670	-2913	3	5	899381
1.80	1.54	6/16/22	13:19	-699	-2923	3	4	899381
1.79	1.54	6/16/22	13:23	-639	-2856	3	5	899381

1.77	1.54	6/16/22	13:28	-312	1108	2	-1	899381
1.77	1.54	6/16/22	13:31	-287	1108	2	-1	899381
1.77	1.53	6/16/22	13:34	-262	1108	2	-1	899381
1.76	1.53	6/16/22	13:37	-237	1108	3	-1	899381

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1.76	1.55	6/16/22	13:42	1319	-2626	3	4	899381
1.76	1.54	6/16/22	13:45	1322	-2582	4	3	899381
1.76	1.54	6/16/22	13:49	1282	-2544	3	4	899381
1.76	1.54	6/16/22	13:53	1461	-3186	2	2	899381
1.76	1.55	6/16/22	13:56	1532	-3164	2	1	899381
1.76	1.54	6/16/22	14:01	-2467	-4523	-4	8	899381
1.76	1.53	6/16/22	14:04	-2498	-4630	-4	7	899381
1.75	1.54	6/16/22	14:11	-1066	-4279	0	6	899381
1.74	1.54	6/16/22	14:14	-994	-4520	0	5	899381
1.73	1.54	6/16/22	14:19	75	-4029	2	5	899381
1.73	1.54	6/16/22	14:22	67	-3996	2	4	899381
1.72	1.55	6/16/22	14:26	45	-4120	1	5	899381

1.71	1.53	6/16/22	14:31	-312	1083	6	3	899381
1.71	1.55	6/16/22	14:34	-287	1083	5	-1	899381
1.71	1.53	6/16/22	14:37	-262	1083	5	-1	899381
1.71	1.53	6/16/22	14:40	-237	1083	5	-1	899381

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1.82	1.56	6/16/22	14:53	413	-4041	4	6	899381
1.85	1.55	6/16/22	14:56	393	-4023	4	5	899381
1.85	1.54	6/16/22	15:00	440	-4076	4	4	899381
1.85	1.54	6/16/22	15:03	459	-4126	4	4	899381
1.85	1.55	6/16/22	15:07	1814	-3858	6	6	899381
1.84	1.54	6/16/22	15:11	1797	-3942	6	6	899381
1.85	1.54	6/16/22	15:14	1775	-3983	6	6	899381
1.84	1.54	6/16/22	15:18	1763	-3836	6	6	899381
1.83	1.55	6/16/22	15:24	2191	-3903	6	4	899381
1.83	1.55	6/16/22	15:28	2225	-3826	7	4	899381
1.83	1.55	6/16/22	15:31	2251	-3792	7	3	899381
1.82	1.55	6/16/22	15:36	2377	-3797	7	2	899381

1.81	1.56	6/16/22	15:42	-55	1167	1	0	899381
1.81	1.55	6/16/22	15:45	-30	1167	1	0	899381
1.80	1.55	6/16/22	15:48	-5	1167	1	0	899381
1.80	1.55	6/16/22	15:51	20	1167	1	-1	899381

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1.78	1.55	6/16/22	16:17	1250	1340	-1	5	899388
1.78	1.54	6/16/22	16:20	1250	1315	-2	5	899388
1.78	1.53	6/16/22	16:23	1250	1290	-2	6	899388
1.78	1.53	6/16/22	16:27	1250	1265	-2	5	899388

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1.77	1.57	6/16/22	16:32	3219	-1607	-3	-1	899388
1.76	1.56	6/16/22	16:37	3231	-1631	-4	0	899388
1.77	1.55	6/16/22	16:41	3112	-1723	-2	2	899388
1.75	1.58	6/16/22	16:46	-2803	-1069	4	3	899388
1.75	1.57	6/16/22	16:50	-2758	-1051	4	2	899388
1.74	1.55	6/16/22	16:55	-2432	-1092	3	3	899388
1.74	1.55	6/16/22	16:59	-2455	-1072	3	3	899388
1.74	1.55	6/16/22	17:02	-2594	-1139	3	3	899388
1.73	1.55	6/16/22	17:08	-1958	-1225	3	2	899388
1.73	1.55	6/16/22	17:12	-2005	-1272	3	2	899388
1.73	1.55	6/16/22	17:16	418	-1914	-1	1	899388
1.73	1.55	6/16/22	17:20	414	-1868	-2	1	899388
1.72	1.55	6/16/22	17:24	372	-1884	-1	0	899388

1.71	1.54	6/16/22	17:30	1275	1340	-2	5	899388
1.71	1.53	6/16/22	17:33	1275	1315	-2	5	899388

1.80	1.55	6/16/22	17:38	1275	1290	-2	5	899388
1.83	1.54	6/16/22	17:42	1275	1265	-1	5	899388
	1.54							
	1.54							
1.83	1.56	6/16/22	17:46	-2551	-1428	4	2	899388
1.84	1.56	6/16/22	17:50	-2578	-1481	4	2	899388
1.83	1.55	6/16/22	17:54	-2677	-1502	3	2	899388
1.83	1.55	6/16/22	17:58	30	-2298	0	-1	899388
1.83	1.55	6/16/22	18:02	102	-2206	-1	0	899388
1.82	1.56	6/16/22	18:06	134	-2235	0	-1	899388
1.82	1.56	6/16/22	18:10	824	-2461	-2	0	899388
1.82	1.55	6/16/22	18:14	795	-2435	-1	0	899388
1.82	1.55	6/16/22	18:18	977	-2372	-2	0	899388
1.81	1.56	6/16/22	18:22	754	-2525	-2	0	899388
1.81	1.54	6/16/22	18:26	1517	-2596	-2	0	899388
1.82	1.56	6/16/22	18:30	1586	-2603	-2	0	899388
1.82	1.55	6/16/22	18:34	1633	-2569	-2	0	899388
1.83	1.55	6/16/22	18:40	1329	1346	-2	5	899388
1.84	1.53	6/16/22	18:43	1329	1321	-2	5	899388
1.84	1.52	6/16/22	18:46	1329	1296	-2	5	899388
1.83	1.53	6/16/22	18:49	1329	1271	-2	4	899388
	1.53							
	1.54							
1.82	1.55	6/16/22	18:54	1932	-2670	-2	1	899388
1.81	1.55	6/16/22	18:58	1882	-2662	-2	0	899388
1.81	1.56	6/16/22	19:02	1995	-2572	-3	0	899388
1.81	1.55	6/16/22	19:05	2060	-2659	-3	0	899388
1.81	1.55	6/16/22	19:10	2687	-2895	-3	1	899388
1.81	1.54	6/16/22	19:14	2803	-2856	-3	1	899388
1.80	1.57	6/16/22	19:18	-2712	-1963	4	2	899388
1.80	1.55	6/16/22	19:22	-2690	-1925	4	1	899388
1.79	1.56	6/16/22	19:26	-1560	-2231	1	0	899388
1.78	1.55	6/16/22	19:30	-1522	-2180	2	0	899388
1.76	1.55	6/16/22	19:35	-2968	-2171	3	2	899388
1.75	1.55	6/16/22	19:38	-2993	-2191	3	1	899388
1.74	1.56	6/16/22	19:42	-2784	-2365	3	1	899388
1.73	1.56	6/16/22	19:46	-2768	-2274	3	1	899388
1.73	1.56	6/16/22	19:50	-1897	-2639	3	0	899388
1.72	1.55	6/16/22	19:55	-1787	-2629	3	0	899388
1.72	1.55	6/16/22	19:59	1354	1346	-2	5	899388
1.71	1.53	6/16/22	20:02	1354	1321	-2	5	899388

1.71	1.54	6/16/22	20:06	1354	1296	-2	5	899388
1.81	1.55	6/16/22	20:11	1354	1271	-2	5	899388

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1.78	1.55	6/16/22	21:17	-535	-2080	5	2	899388
1.77	1.56	6/16/22	21:21	-510	-2080	5	2	899388
1.77	1.55	6/16/22	21:24	-485	-2080	4	2	899388
1.78	1.55	6/16/22	21:27	-460	-2080	4	2	899388

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1.77	1.55	6/16/22	21:30	-2193	204	11	8	899388
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1.75	1.56	6/16/22	21:46	-535	-2055	4	0	899352
1.75	1.56	6/16/22	21:49	-510	-2055	4	1	899352
1.75	1.56	6/16/22	21:52	-485	-2055	4	1	899352
1.74	1.55	6/16/22	21:55	-460	-2055	4	1	899352

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1.74	1.55	6/16/22	21:58	-2166	200	11	7	899352
1.74	1.54	6/16/22	22:01	-2147	178	11	6	899352
1.73	1.55	6/16/22	22:04	-2102	258	11	6	899352
1.72	1.55	6/16/22	22:07	-1903	275	11	7	899352
1.72	1.54	6/16/22	22:10	-1931	300	11	7	899352
1.81	1.56	6/16/22	22:15	-1921	212	10	7	899352
1.84	1.57	6/16/22	22:18	-1891	391	11	7	899352
1.85	1.55	6/16/22	22:21	-867	643	8	9	899352
1.85	1.55	6/16/22	22:24	-885	653	8	9	899352
1.85	1.54	6/16/22	22:27	-911	673	8	9	899352
1.84	1.54	6/16/22	22:30	1452	1292	2	12	899352
1.84	1.54	6/16/22	22:33	1486	1320	2	12	899352
1.84	1.54	6/16/22	22:36	1562	1409	2	11	899352
1.83	1.54	6/16/22	22:39	1224	830	2	10	899352
1.82	1.54	6/16/22	22:42	1182	795	2	10	899352

1.82	1.53	6/16/22	22:45	-535	-2105	4	1	899352
1.81	1.54	6/16/22	22:48	-510	-2105	4	0	899352
1.81	1.54	6/16/22	22:51	-485	-2105	3	1	899352
1.80	1.53	6/16/22	22:54	-460	-2105	4	1	899352

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1.80	1.54	6/16/22	22:57	1239	769	1	10	899352
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1.80	1.53	6/16/22	23:00	2130	1217	1	12	899352
1.79	1.54	6/16/22	23:03	2160	1248	1	12	899352
1.79	1.54	6/16/22	23:06	2176	1304	1	12	899352
1.78	1.54	6/16/22	23:09	2107	639	0	9	899352
1.78	1.54	6/16/22	23:12	2172	720	0	9	899352
1.78	1.53	6/16/22	23:15	2014	612	0	10	899352
1.77	1.54	6/16/22	23:18	2457	803	-1	10	899352
1.77	1.54	6/16/22	23:21	2512	954	-1	11	899352
1.76	1.53	6/16/22	23:24	2448	942	0	11	899352
1.75	1.55	6/16/22	23:27	-1744	-976	8	4	899352
1.76	1.55	6/16/22	23:30	-1769	-971	7	5	899352
1.76	1.54	6/16/22	23:33	1473	152	0	8	899352
1.75	1.54	6/16/22	23:36	1475	123	0	8	899352
1.74	1.54	6/16/22	23:39	2787	693	-2	10	899352
1.74	1.54	6/16/22	23:42	2821	696	-2	10	899352

1.73	1.53	6/16/22	23:45	-535	-2130	4	1	899352
1.73	1.53	6/16/22	23:48	-510	-2130	4	0	899352
1.73	1.53	6/16/22	23:51	-485	-2130	3	1	899352
1.72	1.52	6/16/22	23:54	-460	-2130	3	1	899352

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1.72	1.53	6/16/22	23:57	2831	679	-2	9	899352
1.72	1.53	6/17/22	0:00	2736	642	-2	10	899352
1.80	1.57	6/17/22	0:05	-1938	-1376	10	2	899352
1.83	1.56	6/17/22	0:08	-1977	-1361	10	2	899352
1.85	1.56	6/17/22	0:11	-1648	-1190	8	4	899352
1.85	1.55	6/17/22	0:14	-1636	-1229	8	4	899352
1.86	1.56	6/17/22	0:17	-1643	-1133	7	4	899352
1.85	1.54	6/17/22	0:20	-2135	-1681	10	3	899352
1.85	1.55	6/17/22	0:23	-2139	-1737	10	4	899352
1.84	1.55	6/17/22	0:26	-2188	-1759	10	4	899352
1.84	1.55	6/17/22	0:29	-1180	-1429	6	4	899352
1.84	1.55	6/17/22	0:32	-1158	-1457	6	3	899352
1.83	1.55	6/17/22	0:35	-1209	-1475	6	3	899352
1.82	1.55	6/17/22	0:38	312	-839	2	4	899352
1.82	1.54	6/17/22	0:41	266	-870	2	4	899352
1.81	1.55	6/17/22	0:44	319	-880	2	3	899352

1.81	1.53	6/17/22	0:47	-535	-2155	3	1	899352
1.80	1.53	6/17/22	0:50	-510	-2155	3	1	899352
1.80	1.53	6/17/22	0:53	-485	-2155	3	1	899352
1.79	1.53	6/17/22	0:56	-460	-2155	4	1	899352

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1.78	1.55	6/17/22	0:59	236	-901	2	4	899352
1.78	1.55	6/17/22	1:02	1007	-580	1	5	899352
1.78	1.55	6/17/22	1:05	1066	-605	0	5	899352
1.78	1.54	6/17/22	1:08	1125	-566	0	5	899352
1.78	1.54	6/17/22	1:11	2114	-338	-2	7	899352
1.78	1.54	6/17/22	1:14	2125	-376	-2	6	899352
1.77	1.54	6/17/22	1:17	2034	-314	-2	8	899352
5.16	0.53	6/17/22	1:20	2199	-278	-1	7	899352
1.78	1.53	6/17/22	1:23	2422	-127	-1	6	899352
1.76	1.54	6/17/22	1:26	2427	-175	-1	7	899352
1.76	1.53	6/17/22	1:29	2398	-160	-1	7	899352
1.76	1.54	6/17/22	1:32	3184	81	-3	8	899352
1.75	1.54	6/17/22	1:35	3204	120	-3	8	899352
1.75	1.53	6/17/22	1:38	3138	61	-3	8	899352

1.75	1.53	6/17/22	1:41	-535	-2180	3	1	899352
1.75	1.53	6/17/22	1:44	-510	-2180	3	1	899352
1.74	1.53	6/17/22	1:47	-485	-2180	3	1	899352
1.73	1.53	6/17/22	1:50	-460	-2180	3	1	899352

1.53**1.53**

1.80	1.54	6/17/22	8:42	-571	1851	7	3	899356
1.80	1.54	6/17/22	8:45	-546	1851	6	3	899356
1.80	1.53	6/17/22	8:48	-521	1851	6	3	899356
1.80	1.53	6/17/22	8:51	-496	1851	6	3	899356

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1.79	1.53	6/17/22	8:56	-2661	-513	8	2	899356
1.78	1.53	6/17/22	8:59	-2616	-479	8	0	899356
1.77	1.53	6/17/22	9:03	-2639	-446	8	0	899356
1.77	1.53	6/17/22	9:07	-2353	-548	8	1	899356
1.76	1.54	6/17/22	9:10	-2305	-515	7	1	899356
1.75	1.59	6/17/22	9:14	-1897	-526	8	1	899356
1.74	1.53	6/17/22	9:17	-1941	-504	7	1	899356
1.74	1.54	6/17/22	9:22	-1855	-433	7	1	899356
1.73	1.54	6/17/22	9:26	-1875	-402	7	1	899356
1.72	1.54	6/17/22	9:31	-1108	-439	7	1	899356
1.72	1.54	6/17/22	9:34	-1014	-286	6	1	899356
1.72	1.54	6/17/22	9:38	-1169	-578	6	1	899356
1.71	1.54	6/17/22	9:42	-617	-412	6	1	899356
1.71	1.53	6/17/22	9:46	-627	-363	6	-1	899356

1.77	1.56	6/17/22	9:50	-596	-298	5	0	899356
1.83	1.54	6/17/22	9:54	1239	-459	5	0	899356
1.83	1.54	6/17/22	9:57	1281	-354	6	0	899356

1.83	1.54	6/17/22	10:02	-571	1826	5	1	899356
1.83	1.54	6/17/22	10:05	-546	1826	5	1	899356
1.82	1.53	6/17/22	10:08	-521	1826	5	0	899356
1.82	1.53	6/17/22	10:11	-496	1826	5	1	899356

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1.81	1.52	6/17/22	10:15	1315	-392	5	0	899356
1.79	1.53	6/17/22	10:19	1588	-343	6	-1	899356
1.79	1.54	6/17/22	10:22	1675	-201	6	-1	899356
1.78	1.54	6/17/22	10:27	485	-1196	6	-1	899356
1.77	1.54	6/17/22	10:31	339	-1252	5	-1	899356
1.77	1.55	6/17/22	10:35	532	-971	6	-1	899356
1.77	1.53	6/17/22	10:39	778	-995	6	-2	899356
1.76	1.53	6/17/22	10:43	777	-903	6	-1	899356
1.76	1.54	6/17/22	10:46	719	-883	5	-1	899356
1.76	1.54	6/17/22	10:50	3114	-1160	6	1	899356
1.76	1.54	6/17/22	10:53	3009	-1220	6	-1	899356
1.75	1.55	6/17/22	10:57	3037	-1369	6	0	899356
1.75	1.53	6/17/22	11:00	2970	-1814	7	-2	899356
1.75	1.54	6/17/22	11:04	2893	-1801	6	-1	899356
1.74	1.52	6/17/22	11:08	-3082	-2787	7	1	899356
1.74	1.53	6/17/22	11:12	-3123	-2715	8	1	899356

1.74	1.54	6/17/22	11:16	-571	1801	5	-1	899356
1.74	1.54	6/17/22	11:19	-546	1801	5	0	899356
1.73	1.54	6/17/22	11:22	-521	1801	5	0	899356
1.73	1.53	6/17/22	11:25	-496	1801	5	-1	899356

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1.72	1.54	6/17/22	11:30	-3210	-2628	7	0	899356
1.72	1.52	6/17/22	11:34	-1324	-2497	6	0	899356
1.71	1.55	6/17/22	11:38	-1275	-2416	5	-2	899356
1.71	1.54	6/17/22	11:41	-1390	-2521	6	0	899356
1.70	1.55	6/17/22	11:45	675	-2486	6	-2	899356
1.77	1.55	6/17/22	11:49	667	-2597	6	-2	899356
1.82	1.53	6/17/22	11:52	683	-2628	6	-2	899356
1.83	1.54	6/17/22	11:56	2767	-3133	8	-3	899356
1.83	1.54	6/17/22	11:59	2740	-3151	8	-3	899356
1.82	1.53	6/17/22	12:03	2785	-3104	8	-2	899356

1.82	1.57	6/17/22	12:07	-835	-3947	6	-2	899356
1.82	1.54	6/17/22	12:10	-773	-3968	6	-2	899356
1.81	1.54	6/17/22	12:14	-737	-3966	6	-3	899356
1.81	1.54	6/17/22	12:18	-763	-3871	6	-3	899356

1.80	1.53	6/17/22	12:22	-571	1776	5	-1	899356
1.80	1.54	6/17/22	12:25	-546	1776	5	-1	899356
1.79	1.54	6/17/22	12:28	-521	1776	5	0	899356
1.78	1.53	6/17/22	12:31	-496	1776	5	-1	899356

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L2p-bkg	H1-bkg	$^{16}\text{OH}/^{16}\text{O}$	Chamber Pressure	$^{16}\text{OH}/^{16}\text{O}$ bg-corrected	Relative Yield
827662	93793	2.21E-04	2.50E-08		
827662	93793	1.86E-04	2.50E-08		
827662	93793	1.88E-04	2.50E-08		
827662	93793	1.90E-04	2.50E-08		
		1.96E-04			
827662	93793	1.84E-04	2.50E-08		
827662	93793	1.83E-04	2.50E-08		
827662	93793	1.88E-04	2.50E-08		
827662	93793	1.91E-04	2.50E-08		
		1.86E-04			
		1.91E-04			
827662	93793	4.58E-04	5.00E-08		
827662	93793	4.63E-04	4.90E-08		
827662	93793	4.66E-04	5.00E-08		
827662	93793	4.69E-04	5.00E-08		
		4.64E-04			
827662	93793	6.71E-04	5.10E-08	1.91E-04	1.00
827662	93793	6.30E-04	5.00E-08	1.50E-04	1.00
827662	93793	6.28E-04	5.00E-08	1.48E-04	1.01
827662	93793	6.06E-04	5.10E-08	1.27E-04	1.01
827662	93793	5.56E-04	5.10E-08	7.57E-05	1.01
827662	93793	5.94E-04	5.10E-08	1.14E-04	1.01
827662	93793	5.33E-04	5.10E-08	5.30E-05	1.01
827662	93793	5.69E-04	5.10E-08	8.96E-05	1.01
827662	93793	5.27E-04	5.10E-08	4.69E-05	1.01
827662	93793	5.12E-04	5.20E-08	3.18E-05	0.99
827662	93793	4.95E-04	5.20E-08		
827662	93793	4.94E-04	5.10E-08		
827662	93793	4.98E-04	5.20E-08		
827662	93793	4.97E-04	5.10E-08		
		4.96E-04			
		4.80E-04			
827662	93793	5.18E-04	5.20E-08	2.56E-05	1.02
827662	93793	5.36E-04	5.20E-08	4.40E-05	1.01
827662	93793	5.81E-04	5.20E-08	8.86E-05	1.01
827662	93793	5.84E-04	5.10E-08	9.18E-05	1.01

827662	93793	5.92E-04	5.20E-08	1.00E-04	1.01
827662	93793	6.01E-04	5.20E-08	1.09E-04	1.01
827662	93793	4.77E-04	5.20E-08	-1.46E-05	1.01
827662	93793	4.81E-04	5.20E-08	-1.13E-05	1.01
827662	93793	6.96E-04	5.20E-08	2.03E-04	1.01
827662	93793	5.80E-04	5.20E-08	8.82E-05	1.00

827662	93793	4.84E-04	5.30E-08
827662	93793	4.89E-04	5.20E-08
827662	93793	4.91E-04	5.20E-08
827662	93793	4.90E-04	5.20E-08

4.88E-04

4.92E-04

827662	93793	3.84E-04	4.40E-08
851950	94127	3.75E-04	4.40E-08
851950	94127	3.72E-04	4.40E-08
851950	94127	3.73E-04	4.40E-08
851950	94127	3.74E-04	4.40E-08

3.74E-04

851950	94127	3.84E-04	4.90E-08
851950	94127	3.95E-04	4.90E-08
851950	94127	4.06E-04	5.00E-08
851950	94127	4.13E-04	5.00E-08

3.99E-04

851950	94127	6.19E-04	5.00E-08	2.05E-04	1.01
851950	94127	6.17E-04	5.00E-08	2.03E-04	1.00
851950	94127	6.10E-04	5.10E-08	1.96E-04	1.01
851950	94127	5.61E-04	5.10E-08	1.47E-04	1.00
851950	94127	5.86E-04	5.10E-08	1.73E-04	0.99
851950	94127	5.55E-04	5.20E-08	1.41E-04	1.01
851950	94127	5.89E-04	5.10E-08	1.75E-04	1.01
851950	94127	6.33E-04	5.10E-08	2.19E-04	1.00
851950	94127	6.23E-04	5.10E-08	2.09E-04	1.00
851950	94127	6.27E-04	5.10E-08	2.14E-04	1.00
851950	94127	5.81E-04	5.10E-08	1.67E-04	1.00
851950	94127	4.22E-04	5.10E-08	8.86E-06	0.99

851950	94127	4.44E-04	5.10E-08
851950	94127	4.25E-04	5.10E-08
851950	94127	4.18E-04	5.10E-08
851950	94127	4.24E-04	5.10E-08

4.28E-04

4.14E-04

851950	94127	5.18E-04	5.10E-08	8.47E-05	1.00
851950	94127	6.00E-04	5.00E-08	1.67E-04	1.02
851950	94127	6.28E-04	5.10E-08	1.95E-04	1.01
851950	94127	6.43E-04	5.10E-08	2.10E-04	1.01
851950	94127	5.99E-04	5.10E-08	1.66E-04	1.03
851950	94127	5.82E-04	5.10E-08	1.49E-04	1.02
851950	94127	5.76E-04	5.10E-08	1.43E-04	1.01
851950	94127	6.22E-04	5.10E-08	1.89E-04	1.02
851950	94127	6.32E-04	5.10E-08	1.99E-04	1.02
851950	94127	5.79E-04	5.10E-08	1.46E-04	1.01
851950	94127	6.03E-04	5.10E-08	1.70E-04	1.02
851950	94127	6.00E-04	5.20E-08	1.67E-04	1.02

851950	94127	4.38E-04	5.10E-08
851950	94127	4.39E-04	5.10E-08
851950	94127	4.41E-04	5.10E-08
851950	94127	4.35E-04	5.10E-08

4.38E-04

4.33E-04

851950	94127	3.33E-04	4.20E-08
851950	94127	3.44E-04	4.20E-08
851950	94127	3.49E-04	4.20E-08
851950	94127	3.49E-04	4.20E-08

3.44E-04

851950	94127	3.92E-04	4.20E-08	4.02E-05	1.00
851950	94127	7.12E-04	4.30E-08	3.60E-04	1.00
851950	94127	4.15E-04	4.30E-08	6.30E-05	1.00
851950	94127	4.24E-04	4.30E-08	7.25E-05	1.00
851950	94127	4.43E-04	4.30E-08	9.10E-05	1.01
851950	94127	5.06E-04	4.30E-08	1.54E-04	1.01
851950	94127	3.90E-04	4.30E-08	3.79E-05	1.00
851950	94127	4.68E-04	4.40E-08	1.16E-04	1.01
851950	94127	4.32E-04	4.40E-08	8.04E-05	1.00
851950	94127	3.57E-04	4.40E-08	4.68E-06	1.01
851950	94127	3.89E-04	4.40E-08	3.68E-05	1.02
851950	94127	3.97E-04	4.40E-08	4.54E-05	1.00

851950	94127	3.61E-04	4.40E-08
851950	94127	3.62E-04	4.40E-08

851950	94127	3.61E-04	4.40E-08		
851950	94127	3.57E-04	4.40E-08		
		3.60E-04			
		3.52E-04			
851950	94127	3.54E-04	4.40E-08	-1.09E-05	1.00
851950	94127	5.80E-04	4.40E-08	2.15E-04	1.01
851950	94127	3.53E-04	4.40E-08	-1.17E-05	1.01
851950	94127	6.34E-04	4.40E-08	2.69E-04	1.01
851950	94127	5.24E-04	4.40E-08	1.60E-04	1.01
851950	94127	3.94E-04	4.40E-08	2.96E-05	1.00
851950	94127	5.18E-04	4.40E-08	1.53E-04	1.00
851950	94127	4.65E-04	4.40E-08	1.01E-04	1.00
851950	94127	4.31E-04	4.50E-08	6.67E-05	1.00
851950	94127	3.70E-04	4.40E-08	5.79E-06	1.00
851950	94127	4.49E-04	4.40E-08	8.48E-05	1.00
851950	94127	3.68E-04	4.40E-08	2.85E-06	1.01
851950	94127	4.47E-04	4.40E-08	8.19E-05	1.01
851950	94127	3.99E-04	4.40E-08	3.40E-05	1.00
851950	94127	3.67E-04	4.40E-08		
851950	94127	3.70E-04	4.40E-08		
851950	94127	3.70E-04	4.40E-08		
851950	94127	3.70E-04	4.40E-08		
		3.69E-04			
		3.65E-04			
851950	94127	4.94E-04	4.30E-08	1.21E-04	1.01
851950	94127	4.55E-04	4.40E-08	8.16E-05	1.00
851950	94127	4.03E-04	4.40E-08	2.98E-05	1.00
851950	94127	3.66E-04	4.40E-08	-6.72E-06	1.01
851950	94127	5.46E-04	4.40E-08	1.73E-04	1.01
851950	94127	4.33E-04	4.40E-08	6.00E-05	1.00
851950	94127	3.94E-04	4.40E-08	2.14E-05	1.00
851950	94127	4.46E-04	4.40E-08	7.26E-05	1.00
851950	94127	5.34E-04	4.30E-08	1.61E-04	1.00
851950	94127	5.00E-04	4.40E-08	1.27E-04	1.00
851950	94127	4.78E-04	4.40E-08	1.05E-04	1.00
851950	94127	4.31E-04	4.40E-08	5.78E-05	1.01
851950	94127	3.81E-04	4.40E-08		
851950	94127	3.81E-04	4.40E-08		
851950	94127	3.72E-04	4.40E-08		
851950	94127	3.73E-04	4.40E-08		
		3.77E-04			

3.73E-04

851950	94127	4.15E-04	4.40E-08	4.54E-05	1.01
851950	94127	3.77E-04	4.40E-08	7.36E-06	1.00
851950	94127	3.72E-04	4.30E-08	2.83E-06	1.00
851950	94127	4.13E-04	4.30E-08	4.39E-05	1.00
851950	94127	3.74E-04	4.40E-08	4.60E-06	1.00
851950	94127	4.04E-04	4.40E-08	3.43E-05	1.00
851950	94127	3.82E-04	4.30E-08	1.22E-05	1.00
851950	94127	3.73E-04	4.30E-08	3.51E-06	1.00
851950	94127	3.66E-04	4.40E-08	-3.20E-06	1.00
851950	94127	3.86E-04	4.40E-08	1.62E-05	1.00
851950	94127	3.53E-04	4.40E-08	-1.59E-05	1.00
851950	94127	3.61E-04	4.40E-08	-7.89E-06	1.00

851950	94127	3.53E-04	4.40E-08
851950	94127	3.67E-04	4.40E-08
851950	94127	3.65E-04	4.30E-08
851950	94127	3.64E-04	4.40E-08

3.62E-04

3.69E-04

851950	94127	3.55E-04	4.70E-08
851950	94127	3.72E-04	4.70E-08
851950	94127	3.77E-04	4.70E-08
851950	94127	3.80E-04	4.70E-08

3.71E-04

851950	94127	6.58E-04	4.80E-08	2.73E-04	1.02
851950	94127	6.66E-04	4.80E-08	2.81E-04	1.01
851950	94127	7.53E-04	4.90E-08	3.68E-04	1.01
851950	94127	6.82E-04	4.90E-08	2.97E-04	1.03
851950	94127	6.52E-04	4.90E-08	2.67E-04	1.02
851950	94127	4.66E-04	4.90E-08	8.14E-05	1.01
851950	94127	4.65E-04	4.90E-08	8.05E-05	1.01
851950	94127	5.11E-04	4.90E-08	1.26E-04	1.01
851950	94127	4.75E-04	4.90E-08	8.97E-05	1.00
851950	94127	4.35E-04	4.90E-08	5.05E-05	1.01
851950	94127	6.39E-04	4.90E-08	2.54E-04	1.01
851950	94127	4.92E-04	4.90E-08	1.07E-04	1.00
851950	94127	4.71E-04	4.90E-08	8.60E-05	1.01

851950	94127	3.99E-04	5.00E-08
851950	94127	4.12E-04	5.00E-08

851950	94127	3.96E-04	5.00E-08		
851950	94127	3.89E-04	5.00E-08		
		3.99E-04			
		3.85E-04			
851950	94127	6.11E-04	5.00E-08	2.14E-04	1.02
851950	94127	6.34E-04	4.90E-08	2.38E-04	1.01
851950	94127	4.66E-04	4.90E-08	6.94E-05	1.01
851950	94127	5.17E-04	5.00E-08	1.20E-04	1.01
851950	94127	4.45E-04	4.90E-08	4.89E-05	1.01
851950	94127	8.96E-04	5.00E-08	4.99E-04	1.02
851950	94127	7.26E-04	4.90E-08	3.29E-04	1.01
851950	94127	4.57E-04	5.00E-08	6.00E-05	1.00
851950	94127	4.25E-04	5.00E-08	2.83E-05	1.01
851950	94127	2.49E-03	5.00E-08	2.10E-03	1.02
851950	94127	5.32E-04	5.00E-08	1.35E-04	1.00
851950	94127	6.27E-04	5.00E-08	2.31E-04	1.01
851950	94127	4.71E-04	5.00E-08	7.40E-05	1.01
851950	94127	3.97E-04	5.00E-08		
851950	94127	3.96E-04	5.00E-08		
851950	94127	3.92E-04	5.00E-08		
851950	94127	3.92E-04	5.10E-08		
		3.94E-04			
		3.97E-04			
851950	94127	4.20E-04	5.00E-08	2.36E-05	1.01
851950	94127	6.04E-04	5.00E-08	2.08E-04	1.01
851950	94127	5.84E-04	5.00E-08	1.88E-04	1.01
851950	94127	5.24E-04	5.10E-08	1.27E-04	1.01
851950	94127	5.47E-04	5.00E-08	1.51E-04	1.01
851950	94127	4.51E-04	5.00E-08	5.49E-05	1.00
851950	94127	1.11E-03	5.00E-08	7.17E-04	1.02
851950	94127	4.98E-04	5.00E-08	1.02E-04	1.01
851950	94127	4.19E-04	5.00E-08	2.28E-05	1.01
851950	94127	4.51E-04	5.00E-08	5.43E-05	1.01
851950	94127	4.73E-04	5.00E-08	7.60E-05	1.01
851950	94127	4.10E-04	4.90E-08	1.35E-05	1.01
851950	94127	5.41E-04	5.00E-08	1.44E-04	1.01
851950	94127	8.08E-04	5.00E-08	4.12E-04	1.02
851950	94127	5.04E-04	4.90E-08	1.08E-04	1.01
851950	94127	3.99E-04	4.90E-08	2.48E-06	1.01
851950	94127	4.03E-04	4.90E-08		
851950	94127	4.02E-04	5.00E-08		

851950	94127	4.03E-04	4.90E-08
851950	94127	3.87E-04	4.90E-08
3.99E-04			
3.97E-04			

851950	94127	2.89E-04	4.10E-08
851950	94127	2.96E-04	4.10E-08
851950	94127	2.98E-04	4.20E-08
851950	94127	2.98E-04	4.10E-08
2.95E-04			

851950	94127	3.84E-04	4.10E-08	7.80E-05	1.00
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851950	94127	3.10E-04	4.10E-08
851950	94127	3.08E-04	4.10E-08
851950	94127	3.08E-04	4.10E-08
851950	94127	3.10E-04	4.10E-08
3.09E-04			

851950	94127	3.49E-04	4.10E-08	4.38E-05	1.00
851950	94127	3.60E-04	4.10E-08	5.49E-05	1.00
851950	94127	3.66E-04	4.10E-08	6.02E-05	1.00
851950	94127	3.48E-04	4.10E-08	4.24E-05	1.00
851950	94127	3.49E-04	4.10E-08	4.31E-05	1.00
851950	94127	3.48E-04	4.10E-08	4.25E-05	1.01
851950	94127	5.17E-04	4.10E-08	2.12E-04	1.02
851950	94127	3.34E-04	4.00E-08	2.82E-05	1.00
851950	94127	3.29E-04	4.10E-08	2.34E-05	1.00
851950	94127	3.82E-04	4.10E-08	7.65E-05	1.00
851950	94127	3.38E-04	4.10E-08	3.25E-05	1.00
851950	94127	3.69E-04	4.10E-08	6.33E-05	0.99
851950	94127	3.84E-04	4.00E-08	7.84E-05	0.99
851950	94127	3.59E-04	4.10E-08	5.31E-05	1.00
851950	94127	3.55E-04	4.10E-08	4.99E-05	1.00

851950	94127	3.02E-04	4.10E-08
851950	94127	3.02E-04	4.00E-08
851950	94127	3.01E-04	4.10E-08
851950	94127	3.03E-04	4.00E-08
3.02E-04			
3.06E-04			

851950	94127	3.38E-04	4.10E-08	3.27E-05	1.01
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851950	94127	3.62E-04	4.10E-08	5.75E-05	1.00
851950	94127	3.42E-04	4.10E-08	3.73E-05	1.00
851950	94127	3.34E-04	4.10E-08	2.87E-05	1.00
851950	94127	3.47E-04	4.10E-08	4.21E-05	1.01
851950	94127	3.50E-04	4.10E-08	4.48E-05	1.01
851950	94127	3.64E-04	4.10E-08	5.92E-05	1.00
851950	94127	3.51E-04	4.10E-08	4.61E-05	1.00
851950	94127	3.58E-04	4.10E-08	5.33E-05	1.00
851950	94127	3.50E-04	4.10E-08	4.52E-05	1.00
851950	94127	3.40E-04	4.10E-08	3.55E-05	1.01
851950	94127	3.51E-04	4.10E-08	4.58E-05	1.02
851950	94127	3.43E-04	4.10E-08	3.76E-05	1.01
851950	94127	3.54E-04	4.00E-08	4.89E-05	1.00
851950	94127	3.48E-04	4.00E-08	4.34E-05	1.01
851950	94127	3.45E-04	4.10E-08	4.05E-05	1.00

851950	94127	3.07E-04	4.00E-08
851950	94127	3.07E-04	4.10E-08
851950	94127	3.08E-04	4.00E-08
851950	94127	3.10E-04	4.10E-08

3.08E-04

3.05E-04

851950	94127	3.62E-04	4.10E-08	5.92E-05	1.00
851950	94127	3.81E-04	4.00E-08	7.86E-05	1.00
851950	94127	3.31E-04	4.00E-08	2.77E-05	1.02
851950	94127	3.49E-04	4.00E-08	4.63E-05	1.02
851950	94127	3.88E-04	4.00E-08	8.49E-05	1.02
851950	94127	3.48E-04	4.00E-08	4.56E-05	1.01
851950	94127	3.46E-04	4.00E-08	4.29E-05	1.02
851950	94127	3.35E-04	4.00E-08	3.19E-05	1.01
851950	94127	3.29E-04	4.00E-08	2.63E-05	1.01
851950	94127	3.35E-04	4.00E-08	3.17E-05	1.01
851950	94127	3.72E-04	4.00E-08	6.89E-05	1.02
851950	94127	3.34E-04	4.00E-08	3.15E-05	1.01
851950	94127	4.77E-04	4.00E-08	1.74E-04	1.02
851950	94127	3.44E-04	4.00E-08	4.17E-05	1.01
851950	94127	3.50E-04	4.10E-08	4.68E-05	1.01
851950	94127	3.33E-04	4.00E-08	3.05E-05	1.01

851950	94127	2.96E-04	4.00E-08
851950	94127	2.96E-04	4.00E-08
851950	94127	2.99E-04	4.00E-08
851950	94127	3.00E-04	4.00E-08

2.98E-04

3.03E-04

851950	94127	3.59E-04	4.00E-08	6.04E-05	1.01
851950	94127	3.64E-04	4.00E-08	6.63E-05	1.01
851950	94127	4.36E-04	4.00E-08	1.38E-04	1.01
851950	94127	3.60E-04	4.00E-08	6.19E-05	1.01
851950	94127	3.31E-04	4.00E-08	3.34E-05	1.01
851950	94127	3.53E-04	4.00E-08	5.48E-05	1.01
851950	94127	3.07E-04	4.00E-08	8.78E-06	1.00
851950	94127	3.56E-04	4.00E-08	5.81E-05	0.35
851950	94127	3.41E-04	4.00E-08	4.31E-05	1.00
851950	94127	3.40E-04	4.00E-08	4.14E-05	1.01
851950	94127	3.55E-04	4.00E-08	5.69E-05	1.00
851950	94127	3.68E-04	4.00E-08	6.97E-05	1.01
851950	94127	3.28E-04	4.00E-08	2.95E-05	1.00
851950	94127	3.49E-04	4.00E-08	5.11E-05	1.00

851950	94127	2.97E-04	4.00E-08
851950	94127	2.97E-04	4.00E-08
851950	94127	3.00E-04	3.90E-08
851950	94127	3.00E-04	3.90E-08

2.98E-04

2.98E-04

834350	93925	2.20E-04	3.30E-08
834350	93925	2.74E-04	3.40E-08
834350	93925	2.45E-04	3.40E-08
834350	93925	2.29E-04	3.40E-08

2.42E-04

834350	93925	3.43E-04	3.40E-08	8.44E-05	1.00
834350	93925	2.73E-04	3.40E-08	1.43E-05	1.00
834350	93925	3.94E-04	3.40E-08	1.35E-04	1.00
834350	93925	2.55E-04	3.40E-08	-4.19E-06	1.00
834350	93925	3.10E-04	3.40E-08	5.10E-05	1.00
834350	93925	5.37E-04	3.50E-08	2.79E-04	1.04
834350	93925	2.81E-04	3.50E-08	2.17E-05	0.99
834350	93925	2.57E-04	3.50E-08	-1.54E-06	1.00
834350	93925	3.78E-04	3.50E-08	1.19E-04	1.00
834350	93925	2.62E-04	3.50E-08	3.48E-06	1.00
834350	93925	3.05E-04	3.50E-08	4.62E-05	1.00
834350	93925	3.16E-04	3.50E-08	5.68E-05	1.00
834350	93925	3.80E-04	3.50E-08	1.22E-04	1.00
834350	93925	2.92E-04	3.50E-08	3.34E-05	1.00

834350	93925	2.42E-04	3.50E-08	-1.69E-05	1.01
834350	93925	2.53E-04	3.50E-08	-5.92E-06	1.00
834350	93925	2.42E-04	3.50E-08	-1.72E-05	1.00

834350	93925	2.87E-04	3.60E-08		
834350	93925	3.09E-04	3.50E-08		
834350	93925	2.56E-04	3.50E-08		
834350	93925	2.50E-04	3.50E-08		
		2.75E-04			
		2.59E-04			

834350	93925	3.13E-04	3.50E-08	4.16E-05	0.99
834350	93925	2.65E-04	3.60E-08	-6.89E-06	1.00
834350	93925	4.10E-04	3.60E-08	1.39E-04	1.01
834350	93925	2.98E-04	3.60E-08	2.63E-05	1.00
834350	93925	2.93E-04	3.60E-08	2.09E-05	1.01
834350	93925	3.26E-04	3.60E-08	5.38E-05	1.01
834350	93925	2.34E-04	3.60E-08	-3.77E-05	1.00
834350	93925	2.41E-04	3.60E-08	-3.07E-05	1.00
834350	93925	2.65E-04	3.60E-08	-7.02E-06	1.00
834350	93925	3.01E-04	3.60E-08	2.94E-05	1.00
834350	93925	2.40E-04	3.60E-08	-3.23E-05	1.00
834350	93925	3.53E-04	3.60E-08	8.07E-05	1.01
834350	93925	2.81E-04	3.60E-08	9.23E-06	1.00
834350	93925	2.96E-04	3.60E-08	2.41E-05	1.00
834350	93925	3.37E-04	3.60E-08	6.53E-05	0.99
834350	93925	2.70E-04	3.60E-08	-1.62E-06	1.00

834350	93925	3.09E-04	3.60E-08		
834350	93925	2.54E-04	3.60E-08		
834350	93925	2.57E-04	3.60E-08		
834350	93925	2.54E-04	3.60E-08		
		2.68E-04			
		2.72E-04			

834350	93925	3.58E-04	3.50E-08	9.31E-05	1.00
834350	93925	5.18E-04	3.60E-08	2.53E-04	0.99
834350	93925	2.62E-04	3.60E-08	-2.93E-06	1.01
834350	93925	5.37E-04	3.60E-08	2.72E-04	1.00
834350	93925	2.61E-04	3.60E-08	-3.84E-06	1.01
834350	93925	2.76E-04	3.60E-08	1.07E-05	1.01
834350	93925	4.37E-04	3.60E-08	1.72E-04	1.00
834350	93925	2.85E-04	3.60E-08	2.00E-05	1.00
834350	93925	2.51E-04	3.60E-08	-1.35E-05	1.00
834350	93925	2.67E-04	3.60E-08	2.30E-06	1.00

834350	93925	2.25E-03	3.60E-08	1.98E-03	1.02
834350	93925	4.00E-04	3.50E-08	1.35E-04	1.00
834350	93925	6.48E-04	3.50E-08	3.83E-04	1.00
834350	93925	3.34E-04	3.60E-08	6.93E-05	1.00

834350	93925	2.52E-04	3.50E-08
834350	93925	2.70E-04	3.60E-08
834350	93925	2.65E-04	3.60E-08
834350	93925	2.59E-04	3.60E-08

2.62E-04

2.65E-04

Supplemental Table S4: WiscSIMS Oxygen Isotope Results Session 2

Comment	$\delta^{18}\text{O}$ ‰ VSMOW	2SD (ext.)	Mass Bias (‰)	$\delta^{18}\text{O}$ ‰ measured	2SE (int.)
SG-265 UWZ1-01				3.973	0.208
SG-265 UWZ1-02 CsRes=154				4.042	0.132
SG-265 UWZ1-03				4.137	0.177
SG-265 UWZ1-04 CsRes=155				4.010	0.231
Average and 2SD				4.041	0.141
SG-265 -A02-18O-1	5.57	0.15	-0.895	4.675	0.127
SG-265 -A02-18O-2	5.58	0.15	-0.895	4.676	0.214
SG-265 -A04-18O-1	5.39	0.15	-0.895	4.488	0.166
SG-265 -A04-18O-2	5.58	0.15	-0.895	4.676	0.200
SG-265 -A06-18O-1	5.67	0.15	-0.895	4.768	0.201
SG-265 -A06-18O-2 CsRes=157	5.60	0.15	-0.895	4.696	0.202
SG-265 -A07-18O-1	5.87	0.15	-0.895	4.972	0.213
SG-265 -A07-18O-2	5.58	0.15	-0.895	4.676	0.209
SG-265 -A07-18O-3	5.62	0.15	-0.895	4.725	0.165
SG-265 -A08-18O-1	5.66	0.15	-0.895	4.756	0.192
SG-265 -A08-18O-2	5.78	0.15	-0.895	4.883	0.199
SG-265 -A08-18O-3	5.84	0.15	-0.895	4.935	0.200
SG-265 -A14-18O-1	5.87	0.15	-0.895	4.971	0.148
SG-265 -A14-18O-2 CsRes=158	5.65	0.15	-0.895	4.747	0.191
SG-265 -A14-18O-3	5.60	0.15	-0.895	4.696	0.183
SG-265-UWZ1-05				4.151	0.203
SG-265-UWZ1-06				4.196	0.136
SG-265-UWZ1-07 CsRes =159				4.055	0.227
SG-265-UWZ1-10				4.081	0.178
Average and 2SD				4.121	0.129
Bracket Average and 2SD	4.98		-0.895	4.081	0.152
SG-265-A17-18O-1	5.68	0.14	-0.898	4.772	0.211
SG-265-A17-18O-2	5.72	0.14	-0.898	4.817	0.158
SG-265-B05-18O-1	5.59	0.14	-0.898	4.689	0.137
SG-265-B05-18O-2	5.77	0.14	-0.898	4.868	0.198
SG-265-B12-18O-1	5.54	0.14	-0.898	4.638	0.166
SG-265-B16-18O-1	5.61	0.14	-0.898	4.703	0.205
SG-265-B16-18O-1	5.71	0.14	-0.898	4.810	0.129
SG-265-B20-18O-1	5.55	0.14	-0.898	4.646	0.171
SG-265-C05-18O-1	5.79	0.14	-0.898	4.885	0.226
SG-265-C05-18O-2	5.80	0.14	-0.898	4.898	0.193
SG-265-C13-18O-1	5.75	0.14	-0.898	4.847	0.171
SG-265-C13-18O-2	5.61	0.14	-0.898	4.711	0.134

SG-265-UWZ1-11			3.995	0.207
SG-265-UWZ1-12			4.092	0.137
SG-265-UWZ1-13			4.048	0.154
SG-265-UWZ1-14			4.000	0.160
Average and 2SD			4.034	0.091
Bracket Average and 2SD	4.98	-0.898	4.077	0.139

¹⁶ O (Gcps)	IP (nA)	Yield (Gcps/nA)	Date	Time	X	Y	DTFA-X	DTFA-Y
2.70	1.72	1.57	11/10/22	11:23	592	2003	-3	13
2.75	1.75	1.57	11/10/22	11:30	592	1978	-4	9
2.68	1.72	1.56	11/10/22	11:33	642	2023	-4	10
2.77	1.76	1.57	11/10/22	11:38	642	1998	-3	11
		1.57						
2.83	1.79	1.58	11/10/22	11:44	-434	-678	-3	11
2.80	1.78	1.57	11/10/22	11:47	-332	-677	-3	10
2.80	1.77	1.58	11/10/22	11:51	439	-250	-3	11
2.75	1.75	1.57	11/10/22	11:55	458	-172	-3	12
2.68	1.71	1.57	11/10/22	11:58	1091	-157	-3	12
2.82	1.79	1.58	11/10/22	12:05	957	-197	-4	9
2.85	1.81	1.57	11/10/22	12:09	1377	-31	-3	11
2.87	1.82	1.57	11/10/22	12:14	1319	16	-3	11
2.83	1.81	1.56	11/10/22	12:17	1269	-194	-3	12
2.82	1.80	1.56	11/10/22	12:21	1731	-97	-3	11
2.78	1.78	1.56	11/10/22	12:25	1694	-157	-4	11
2.74	1.75	1.57	11/10/22	12:28	1662	-17	-4	10
2.70	1.72	1.57	11/10/22	12:32	3647	163	-4	11
2.78	1.76	1.58	11/10/22	12:37	3712	351	-3	10
2.75	1.76	1.57	11/10/22	12:41	3639	96	-4	11
2.73	1.75	1.56	11/10/22	12:45	682	2023	-4	11
2.68	1.73	1.55	11/10/22	12:48	682	2003	-4	10
2.84	1.80	1.57	11/10/22	12:52	682	1983	-5	11
2.94	1.87	1.57	11/10/22	12:56	682	1963	-5	9
		1.56						
		1.57						
2.96	1.90	1.56	11/10/22	13:00	4742	347	-4	10
2.99	1.90	1.57	11/10/22	13:04	4689	490	-4	9
3.00	1.91	1.57	11/10/22	13:08	52	-831	-4	9
3.01	1.93	1.56	11/10/22	13:11	9	-929	-4	10
3.06	1.95	1.57	11/10/22	13:15	2351	-588	-4	11
3.06	1.96	1.57	11/10/22	13:19	3635	-121	-4	12
3.04	1.94	1.56	11/10/22	13:22	3691	-154	-4	11
3.04	1.93	1.57	11/10/22	13:26	4923	-138	-4	11
3.07	1.96	1.57	11/10/22	13:31	1312	-1017	-4	9
3.13	2.00	1.57	11/10/22	13:34	1369	-1095	-4	10
3.10	1.98	1.56	11/10/22	13:40	2640	-867	-4	9
3.09	1.98	1.56	11/10/22	13:44	2658	-780	-3	10

3.06	1.97	1.56	11/10/22	13:48	682	1920	-4	9
3.02	1.95	1.55	11/10/22	13:51	682	1900	-5	9
3.00	1.93	1.56	11/10/22	13:54	682	1880	-5	9
2.96	1.91	1.55	11/10/22	13:59	705	1921	-5	9

1.55

1.56

Mass	L2p-bkg	H1-bkg	$^{16}\text{OH}/^{16}\text{O}$	Chamber Pressure	$^{16}\text{OH}/^{16}\text{O}$ bg-corrected	Relative Yield
899521	787006	92006	1.87E-04	1.90E-08		
899521	787006	92006	1.91E-04	2.00E-08		
899521	787006	92006	1.84E-04	2.00E-08		
899521	787006	92006	1.98E-04	2.00E-08		
			1.90E-04			
899521	787006	92006	4.81E-04	2.00E-08	2.90E-04	1.01
899521	787006	92006	1.68E-04	2.00E-08	-2.37E-05	1.00
899521	787006	92006	4.00E-04	2.00E-08	2.08E-04	1.01
899521	787006	92006	2.58E-04	2.00E-08	6.67E-05	1.00
899521	787006	92006	2.65E-04	2.00E-08	7.31E-05	1.00
899521	787006	92006	1.70E-04	2.00E-08	-2.16E-05	1.01
899521	787006	92006	1.91E-04	2.00E-08	-4.02E-07	1.00
899521	787006	92006	1.96E-04	2.00E-08	4.82E-06	1.01
899521	787006	92006	1.68E-04	2.00E-08	-2.40E-05	1.00
899521	787006	92006	1.48E-04	2.00E-08	-4.39E-05	1.00
899521	787006	92006	1.52E-04	2.00E-08	-3.99E-05	1.00
899521	787006	92006	1.78E-04	2.00E-08	-1.37E-05	1.00
899521	787006	92006	1.89E-04	2.00E-08	-3.00E-06	1.00
899521	787006	92006	1.90E-04	2.10E-08	-2.02E-06	1.01
899521	787006	92006	2.08E-04	2.10E-08	1.66E-05	1.00
899521	787006	92006	1.86E-04	2.00E-08		
899521	787006	92006	1.96E-04	2.00E-08		
899521	787006	92006	2.00E-04	2.00E-08		
899521	787006	92006	1.92E-04	2.00E-08		
			1.93E-04			
			1.92E-04			
899521	787006	92006	1.49E-04	2.10E-08	-3.41E-05	1.00
899521	787006	92006	2.22E-04	2.10E-08	3.88E-05	1.01
899521	787006	92006	1.59E-04	2.10E-08	-2.43E-05	1.01
899521	787006	92006	1.97E-04	2.00E-08	1.37E-05	1.00
899521	787006	92006	1.67E-04	2.10E-08	-1.60E-05	1.01
899521	787006	92006	2.97E-04	2.10E-08	1.13E-04	1.00
899521	787006	92006	1.67E-04	2.10E-08	-1.63E-05	1.00
899521	787006	92006	1.55E-04	2.10E-08	-2.80E-05	1.01
899521	787006	92006	1.79E-04	2.10E-08	-4.34E-06	1.01
899521	787006	92006	1.79E-04	2.10E-08	-4.01E-06	1.01
899521	787006	92006	1.73E-04	2.10E-08	-9.99E-06	1.00
899521	787006	92006	1.75E-04	2.10E-08	-8.34E-06	1.00

899521	787006	92006	1.73E-04	2.10E-08
899521	787006	92006	1.55E-04	2.10E-08
899521	787006	92006	1.64E-04	2.10E-08
899521	787006	92006	2.01E-04	2.10E-08

1.73E-04

1.83E-04

Supplemental Table S5: WiscSIMS Trace Element Concentrations

Comment	27Al	31P	40Ca	56Fe	89Y	139La	140Ce
SG-122-B04-1	465.9	115.6	62.6	901.0	438.8	7.4	55.5
SG-122-B12-1	40.1	85.8	11.2	7.6	73.0	0.0	1.8
SG-122-C12-1	10.5	179.9	9.5	6.8	612.0	0.2	6.9
SG-122-C15-1	106.2	69.6	36.9	30.1	280.9	0.0	3.8
SG-122-C15-2	83.5	202.2	44.7	47.0	689.3	3.3	33.8
SG-122-C18-1	2.1	133.4	1.2	3.4	594.5	0.0	6.4
SG-122-C18-2	5.6	72.9	1.1	2.7	260.3	0.0	3.0
SG-122-C18-3	2.9	137.9	1.3	14.5	627.9	0.0	4.7
SG-122-C21-1	17.2	167.6	3.9	11.6	812.3	0.2	9.5
SG-122-C21-2	40.0	167.1	8.0	38.9	833.2	0.3	10.6
SG-122-D06-1	11.0	87.7	10.2	21.6	222.9	0.1	4.5
SG-122-D06-2	3.6	63.5	11.6	3.4	151.9	0.0	2.4
SG-122-E01-1	61.9	61.4	157.5	24.8	183.9	3.0	13.0
SG-122-E05-1	6.5	111.2	3.0	4.8	341.1	0.0	3.1
SG-026-A03-1	2.8	181.4	1.1	2.4	1073.9	0.0	24.7
SG-026-A03-2	5.0	160.3	1.0	1.7	476.2	0.0	24.5
SG-026-A04-1	3.5	170.1	1.1	1.7	457.6	0.0	29.6
SG-026-A07-1	2.8	149.4	1.2	3.4	829.9	0.0	25.9
SG-026-A13-1	2.7	145.5	2.3	5.5	446.1	0.0	32.5
SG-026-B12-1	3.5	169.4	1.8	3.4	452.2	0.0	25.5
SG-026-B14-1	4.4	164.2	1.7	3.8	471.5	0.0	27.5
SG-026-C15-1	3.9	129.6	1.6	3.5	361.2	0.0	29.0
SG-026-C16-1	10.5	172.8	76.4	3.8	510.3	179.6	252.8
SG-026-D04-1	5.0	164.6	1.3	4.1	543.7	0.0	30.3
SG-026-D13-1	4.1	148.7	2.3	4.7	391.6	0.0	24.5
SG-026-D17-1	2.5	166.4	1.7	1.8	824.7	0.0	26.8
SG-026-D17-2	2.1	164.7	1.5	3.6	599.0	0.0	28.2
SG-026-E04-1	2.8	203.9	1.3	2.1	584.8	0.0	23.0
SG-026-E04-2	2.4	154.5	1.0	1.6	527.2	0.0	24.6
SG-026-F02-1	2.7	162.1	1.0	2.9	464.7	0.0	27.6
SG-026-F05-1	25.7	8.3	19.6	46.7	46.5	8.1	17.0
SG-026-F05-2	3.0	159.6	1.3	3.1	441.1	0.0	23.5
SG-026-F09-1	90.0	222.8	3.3	4.7	751.9	0.1	24.7
SG-026-F09-2	9.0	169.6	1.5	3.8	508.8	0.0	26.9
SG-026-F11-1	2.9	168.7	1.5	3.5	1043.4	0.0	31.8
SG-026-F14-1	4.7	183.1	3.2	2.6	502.6	0.4	28.2
SG-026-F14-2	9.5	7.0	6.7	25.2	14.3	2.5	5.4
SG-026-F14-3	7.8	136.1	2.1	2.7	347.0	0.0	20.6
SG-026-F15-1	2.4	166.6	2.2	2.2	518.7	0.0	25.5
SG-026-F15-2	2.6	147.3	2.0	6.3	448.6	0.0	33.9
SG-026-F15-2	10.3	131.3	1.6	3.1	315.2	0.0	21.6
SG-027-B14-1	68.1	135.7	110.7	59.4	1239.2	8.9	43.5
SG-027-B14-2	7.9	60.9	8.5	12.5	228.9	0.7	6.9

SG-027-C15-1	11.4	70.6	12.1	21.0	301.5	1.0	10.0
SG-027-C15-1	101.3	67.1	5.2	288.3	288.8	0.2	5.0
SG-027-D07-1	2.3	25.5	1.9	1.2	61.6	0.0	0.1
SG-027-D07-2	2.1	70.1	1.2	1.6	448.2	0.0	0.1
SG-027-D13-1	17.7	105.9	1.2	25.8	546.9	0.0	11.4
SG-027-D17-1	11.8	131.9	1.4	34.7	654.1	0.0	12.1
SG-027-D17-2	28.1	222.3	50.5	24.1	917.2	1.7	16.0
SG-027-E04-1	31.2	119.1	77.7	32.3	787.0	2.2	24.6
SG-027-E04-2	7.1	120.8	2.0	25.4	789.7	0.0	10.5
SG-027-E11-1	44.8	42.4	48.3	1208.8	464.9	0.0	7.3
SG-027-E11-2	3.3	47.1	0.5	17.6	306.2	0.0	3.8
SG-027-F10-1	22.7	39.0	9.7	637.7	356.9	0.0	1.9
SG-027-F10-2	13.4	135.0	0.9	51.5	1355.7	0.0	14.2
SG-027-F15-1	57.3	121.1	2.5	35.4	1078.4	0.0	16.7
SG-027-F15-2	19.5	117.3	1.1	30.2	691.0	0.0	15.4
SG-210c-A01-TE-1	29.6	393.5	10.2	41.1	2528.2	1.8	31.4
SG-210c-A01-TE-2	6.8	178.2	2.2	6.2	1737.2	0.0	7.6
SG-210c-A15-TE-1	1.5	176.1	1.9	18.8	1681.8	0.0	4.9
SG-210c-A15-TE-2	4.7	217.8	3.3	4.7	1179.5	0.4	7.3
SG-210c-B15-TE-1	2.2	223.4	3.3	5.0	892.4	0.0	5.2
SG-210c-B17-TE-1	2.3	192.5	3.3	1.5	546.5	0.0	2.5
SG-210c-C06-TE-1	1.6	277.4	2.2	4.3	1008.3	0.0	3.7
SG-210c-C08-TE-1	1.1	97.6	3.7	1.9	606.0	0.0	4.2
SG-210c-D08-TE-1	2.5	189.1	3.3	11.2	1965.5	0.0	8.5
SG-210c-D10-TE-1	1.7	79.5	3.7	16.5	324.5	0.0	3.9
SG-210c-D10-TE-2	2.9	198.7	4.1	8.2	998.2	0.0	7.8
SG-210c-D11-TE-1	2.4	294.1	2.7	6.0	1677.9	0.0	8.3
SG-210c-D11-TE-2	1.6	177.5	2.8	4.3	869.8	0.0	7.3
SG-210c-D17-TE-1	2.6	368.4	4.4	9.8	1730.5	0.0	8.5
SG-210c-D17-TE-2	1.9	217.6	2.6	4.5	950.1	0.0	7.0
SG-210c-E17-TE-1	1.5	87.5	2.3	4.1	309.1	0.0	3.1
SG-210c-E17-TE-2	83.4	249.3	9.7	10.8	1953.6	0.0	10.1
SG-210c-F01-TE-1	4.2	203.2	2.7	5.0	1155.5	0.0	4.5
SG-210c-F01-TE-2	17.7	118.3	11.8	10.9	647.0	2.3	16.8
SG-210c-F05-TE-1	17.8	126.4	6.2	14.8	602.3	0.0	6.6
SG-210c-F05-TE-2	2.3	191.7	4.5	8.4	1640.9	0.0	6.7
SG-210c-F09-TE-1	1.8	268.9	2.5	3.1	1186.9	0.0	7.7
SG-210c-F09-TE-2	1.7	252.5	3.0	2.7	1128.7	0.0	7.3
SG-210c-F10-TE-1	1.7	197.7	2.5	4.4	995.5	0.0	6.4
SG-210c-F13-TE-1	2.0	300.5	3.3	3.4	1794.8	0.0	8.2
SG-210c-F13-TE-2	4.3	294.6	7.4	5.8	1808.3	0.0	9.5
SG-210c-F14-TE-1	1.7	227.1	6.0	2.9	1248.3	0.0	5.4
SG-127-A01-1	1.8	159.5	0.4	5.2	1872.1	0.0	21.0
SG-127-A16-1	2.1	321.3	0.6	6.9	1450.2	0.0	20.4
SG-127-A16-2	2.2	245.0	0.3	5.0	888.3	0.0	11.9

SG-127-B01-1	1.7	68.4	0.3	1.1	282.2	0.0	5.9
SG-127-B01-2	24.5	212.2	28.6	32.3	1264.3	2.1	33.4
SG-127-B11-1	3.8	532.6	0.4	10.4	1584.5	0.0	7.9
SG-127-B11-1	16.4	416.7	62.3	32.8	1326.8	0.1	7.6
SG-127-B16-1	14.9	98.7	12.1	53.0	162.6	0.7	14.6
SG-127-B16-2	1.2	104.8	0.1	1.1	374.1	0.3	31.5
SG-127-D04-1	1.1	73.5	0.2	3.5	301.4	0.0	7.0
SG-127-D04-2	1.0	92.5	0.3	1.8	352.0	0.0	6.3
SG-127-D06-1	1.7	185.2	0.2	4.9	697.4	0.0	13.1
SG-127-D06-2	6.2	105.2	2.2	7.4	369.8	1.8	16.9
SG-127-E01-1	2.4	67.5	0.3	1.9	191.5	0.0	3.1
SG-127-E01-2	1.2	63.5	0.2	1.9	176.1	0.0	2.4
SG-203-A02-1	1.4	147.7	0.4	3.0	435.4	0.1	7.4
SG-203-A02-2	8.0	103.1	0.5	3.3	603.0	0.1	19.6
SG-203-A03-1	1.2	113.6	0.2	1.6	512.8	0.0	11.4
SG-203-A06-1	11.3	193.6	372.0	60.5	638.1	6.8	28.2
SG-203-A06-2	1.0	130.3	0.4	1.8	615.4	0.0	9.8
SG-203-A07-1	1.1	159.9	1.4	2.8	1401.2	0.0	14.0
SG-203-A12-1	5.5	95.3	3.6	5.6	548.6	0.0	8.0
SG-203-B11-1	5.0	89.3	1.7	3.6	309.0	0.1	9.1
SG-203-B11-2	1.7	162.4	2.8	4.5	770.0	0.0	15.2
SG-203-B12-1	2.0	88.0	0.5	2.1	332.7	0.0	7.3
SG-203-B18-1	1.0	174.6	0.4	3.9	1338.4	0.0	15.5
SG-203-B18-2	1.3	112.7	1.1	2.0	541.3	0.0	11.8
SG-203-C17-1	1.9	105.4	1.9	3.9	580.4	0.5	14.4
SG-203-D02-1	1.1	143.1	0.5	3.1	712.6	0.0	13.6
SG-203-D02-1	1.2	157.9	9.5	0.8	624.6	0.0	11.9
SG-203-D07-2	1.7	90.8	1.9	12.3	802.1	0.0	9.9
SG-203-D12-1	1.6	150.6	3.4	2.3	594.1	0.1	9.2
SG-203-D12-2	1.4	140.6	0.6	2.1	666.6	0.1	13.6
SG-203-E15-1	1.7	169.3	1.4	3.8	689.1	0.1	10.0
SG-203-E15-2	2.0	126.1	5.4	158.1	500.6	0.2	10.1
SG-203-F08-1	1.8	164.0	0.2	3.2	851.5	0.2	18.2
SG-203-F08-2	6.4	113.3	4.9	7.1	494.7	1.0	11.9
SG-265-A02-TE-1	2.1	70.5	23.3	1.8	175.2	0.0	2.3
SG-265-A02-TE-2	2.2	92.9	14.0	2.4	211.1	0.0	2.8
SG-265-A04-TE-1	10.9	221.3	7.2	15.3	511.8	0.2	14.5
SG-265-A04-TE-2	90.0	315.5	10.3	171.5	973.5	0.5	27.0
SG-265-A06-TE-1	54.9	193.0	26.8	1079.7	3545.4	0.2	22.7
SG-265-A06-TE-2	9.7	159.8	1.1	5.7	471.0	0.0	7.1
SG-265-A07-TE-1	36.6	84.5	1.9	4.6	84.6	0.0	2.5
SG-265-A08-TE-1	33.0	98.2	1.1	5.9	120.2	0.0	3.4
SG-265-A08-TE-2	6.1	118.9	1.2	3.7	315.9	0.0	3.9
SG-265-A14-TE-1	3.8	140.9	2.9	5.9	495.1	0.0	7.7
SG-265-A14-TE-2	32.3	95.6	6.9	4.1	137.4	0.4	5.9