Boron isotopes in blue diamond record seawater-derived fluids in the lower mantle

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Abstract

Boron is a quintessential crustal element but its conspicuous presence in diamond – a mantle mineral – raises questions about potential subduction pathways for boron and other volatiles. It has been a long-standing goal to characterize the isotopic composition of boron in blue, boron-bearing (Type IIb) diamonds to reveal its origin. Mineral inclusions indicate that Type IIb diamonds crystallize at transition zone to lower mantle depths, meaning that if the boron is subducted it would trace a pathway of volatile elements into the deep mantle. Here, using off-line laser ablation sampling, we present the first boron isotope compositions, along with trace element contents and carbon isotope compositions, of a suite of blue diamonds mainly sourced from the Cullinan diamond mine in South Africa. The ten analyzed blue diamonds have a wide range in $\delta^{11}B$, between −9.2 ± 2 ‰ and −0.5 ± 2 ‰, compared to the more restricted range for mid-ocean ridge basalts (−7.1 ± 0.9 ‰). Carbon isotope values for the blue diamonds range between −20.6 and −1.8 ‰, with a mode at −17 ‰, significantly more negative than the main mantle mode at −5 ‰. Combined, the boron and carbon isotope compositions require fluid input from subducted

oceanic lithosphere down into deep mantle source regions of blue diamonds. This finding highlights a deep subduction pathway for volatiles to stoke the source regions of deeply-derived magmas.

Keywords

Diamond, Boron, Carbon, Isotopes, Transition Zone, Lower Mantle, Peridotite, Serpentinite

1. Introduction

The subduction of seawater-altered oceanic lithosphere across the 660 km seismic discontinuity provides a potential mechanism for deep volatile enrichment (Berovici & Karato, 2003; Creager & Jordan, 1984; Shirey et al., 2021), however the lithologies and mineral phases that retain volatile elements to lower mantle depths are still uncertain. Rare, boron-bearing blue diamonds (classified as Type IIb) provide a unique opportunity to examine the deep water, boron and carbon cycles, because their mineral inclusions and carbon isotope values indicate they formed in subducted oceanic lithosphere at transition zone to lower mantle depths (Smith et al., 2018). Mineral inclusions in blue diamonds have a clear link to subducted lithologies, raising the prospect that boron impurities in blue diamonds may also have a subducted origin (Smith et al., 2018). Geochemical tracers that would fingerprint the phases responsible for transporting boron and other volatile elements to transition zone and lower mantle depths have remained elusive due to the challenges of analyzing these very pure diamond samples.

Boron isotopes are an ideal tracer of subducted material in the deep mantle due to the large isotopic fractionation that can occur in low-temperature crustal environments during interaction with seawater. Despite the blurring of these distinctive isotopic signatures during the preferential loss of the fluid-mobile

^{11}B isotope (decreasing the residual δ^{11}B) as subducting slabs dehydrate, the isotopic distinction between surface and mantle environments remains strong (de Hoog & Savov, 2018).

Our study of blue diamonds includes the first boron isotope measurements on material directly sourced from the transition zone to lower mantle and is coupled with mineralogical and elemental characterization of the mineral inclusions and crystallographic impurities of blue diamonds. Combined, these data provide us with unique insights into the large-scale cycling and behaviour of volatiles in the deep mantle.

2. Samples and Methods

Here we briefly outline our methodology, with full details of each technique given in the Supplementary Text.

Type IIb diamonds are exceedingly rare, comprising less than 0.02 % of all mined diamonds (Smith et al., 2018). Due to the rarity of Type IIb diamonds, the low abundance of mineral inclusions trapped within them, and their high monetary value, the geological origin of Type IIb diamonds has remained elusive until Smith et al. (2018) proved their transition zone / lower mantle origin. Here we studied 23 fragments of blue Type IIb diamonds from the Cullinan mine (exploiting the 1.15 Ga Premier kimberlite; Kjarsgaard et al., 2022) in South Africa and three diamonds of uncertain provenance (Table 1).

Prior to any destructive analytical work, we collected Raman spectra and X-ray microfluorescence (μXRF) data from two diamonds (NL247-2 and Blue2). Confocal Raman spectra were collected at Northwestern University using a custom-built system with an Olympus BX microscope with 100× and 50× objectives and a Melles-Griot solid-state laser. μXRF was completed at synchrotron beamline 13-IDE (GSECARS, APS, Argonne National Laboratory).

Electron probe microanalysis (EPMA) was completed on an inclusion that was recovered after breaking the enstatite-bearing corner of sample Blue2. The analyses utilized a JEOL JXA-8900R with five wavelength-dispersive spectrometers at the University of Alberta.

Diamonds were mounted in epoxy and/or indium for cathodoluminescence (CL) imaging and secondary ion mass spectrometry (SIMS) analysis at the Canadian Centre for Isotopic Microanalysis. CL imaging was completed using a Zeiss EVO MA15 scanning electron microscope (SEM), with a broadband photomultiplier detector.

Boron abundances in diamonds were determined by SIMS analysis at the Canadian Centre for Isotopic Microanalysis. Boron ($^{11}B^{-}/^{12}C^{-}$) measurements were quantified using the boron concentration of sample NL247-20 as the primary reference material, which was determined by hyperspectral CL (0.185 ± 0.008 μg/g [2σ s.d.]). The hyperspectral CL measurements utilized a FEI Quanta 250 field emission SEM with a Gatan cryo-stage at the University of Calgary. We calculated the boron concentration by monitoring the maximum peak intensity of bound (BE) and free excitons (FE), using a 2400 lines/mm diffraction grating.

Closed-cell laser ablations of the natural blue diamonds for trace elemental analyses were carried out at the University of Alberta using a 193 nm ArF Excimer laser system (RESOlution M-50-LR, Applied Spectra). Samples were analyzed on a Thermo Scientific Element XR ICPMS, with an APEX- Q high-efficiency sample introduction system. This method is described in detail in Krebs et al. (2019). We only report data that are above the limit of quantification (LOQ), defined as the total procedural blank (TPB) + 7σ. Laser ablations for boron isotope analyses were also conducted using a 193 nm ArF Excimer laser system at the University of Alberta with the ablation product being collected in a custom-made Teflon ablation cell that was capped with a silica glass window. This "offline-ablation" method has been described previously (e.g., McNeill et al., 2009). Subsequent solution-based analysis of boron was completed on a Thermo Neptune MC-ICP-MS with a PFA spray chamber at the University of Southampton (National Oceanography Centre Southampton) following established analytical protocols (e.g., Foster, 2008). Details on the analytical techniques are given in the Supplementary Text.

3. Results

3.1. Mineral inclusions

Inclusions were observed in only four diamonds in this suite: sample 110208425476 was previously reported to contain ferropericlase inclusions along with minor olivine and nyerereite ($Na_2Ca(CO_3)_2$) associated with healed fractures (Smith et al., 2018). X-ray diffraction-based barometry of ferropericlase in this diamond established a remnant pressure of 1.8 GPa, which was estimated to require entrapment pressures of at least 10–14 GPa (Smith et al., 2018). Sample DVBT was reported to contain inclusions of breyite (walstromite-structured $CaSiO_3$) and an Fe-Ni-S alloy (Smith et al., 2018). Blue2 and NL247-2 have visible bimineralic inclusions of breyite ($CaSiO_3$) and larnite (Ca_2SiO_4), and Blue2 also has a separate inclusion of enstatite (Figure 1; Data S1). X-ray fluorescence mapping of inclusions in Blue2 and NL247-2 indicates that Fe-Ni rich alloys surround these Ca- and Mg-silicate inclusions (Figure 2). An additional broad graphite peak at ~1580 cm^{-1} in the Raman spectra suggests that these inclusions are similar to the Fe-Ni-C-S inclusions previously documented in sublithospheric CLIPPIR and blue diamonds (Smith et al., 2016, 2018).

Electron probe microanalysis of an additional, single inclusion, recovered after breaking the enstatite-bearing corner of sample Blue2, determined this additional inclusion to be olivine (Data S7). Under equilibrium conditions, the co-presence of breyite and enstatite in this diamond requires formation in the lower mantle, as CaSi- and MgSi-perovskites (bridgmanite; Irifune & Ringwood, 1987). The high NiO content (0.45 wt. %) of the olivine and its close spatial association (possibly touching) with an unrecovered retrogressed bridgmanite (i.e., enstatite) suggest that it formed through retrograde recombination of a composite Ni-rich ferropericlase and high Mg# (where Mg# = 100Mg/(Mg+Fe)) bridgmanite inclusion (Stachel et al., 2000b; Smith et al., 2018). While the high olivine Mg# of 93 implies an ultramafic lithology (bridgmanite must have been > 93), it cannot be used to deduce a depleted or fertile composition, because the initial proportions of ferropericlase and bridgmanite and the final proportions of olivine and orthopyroxene are unknown.

3.2. Internal textures and zoning in blue diamonds

Polygonized dislocation networks are visible in the panchromatic (350–850 nm) CL images of all the blue diamonds studied here (Figure 3). Polygonized dislocation networks are common in sublithospheric diamonds, being especially pronounced in Type IIa and Type IIb varieties, as a result of deformation and annealing in the hot and dynamic environment of the convecting mantle (Smith et al., 2016, 2018). Deformation likely starts as single lattice dislocations that then polygonize into mosaic networks during annealing at high temperatures in the mantle (Hanley et al., 1977; Sumida & Lang, 1981). Dislocation networks are often associated with 'Band A' emission – a broad peak at 435 nm that remains unassigned (Hanley et al., 1977; Graham et al., 1991). Although polygonized dislocation networks are common only in sublithospheric diamonds, single dislocations and 'Band A' emission are also observed along deformation lamellae in lithospheric diamonds (Smit et al., 2018).

The majority of our samples show no regular concentric zoning in their CL emission (Figure 3), but ten samples have broad zones with higher CL emission (NL247-2, -9, -10, -12, -14, -15, -16, -17, -21, -22). Secondary ion mass spectrometry analyses determined that regions with low CL emission have ~ 0.2 μg/g

B, similar to the range (0.1 to 8 μg/g B) reported by Gaillou et al. (2012). Zones with higher CL emission generally have lower B concentrations (Figure 3; ~0.02 μg/g B). This may be because higher boron concentrations quench 'Band A' emission in the dislocation networks, or alternatively that boron quenches nitrogen emission (Collins & Williams, 1971). Nitrogen concentrations in all samples were below the detection limit of SIMS, generally less than 0.5 or 0.35 μg/g (Data S3).

3.3. Trace element content of blue diamonds

Trace element data for blue diamonds are given in Data S2 and the Supplementary Text. The REE_N patterns (where N denotes normalization to chondrite) in the majority of our blue diamonds show enrichment of LREE over HREE, with La_N/Ho_N between 5.4–110 (Figure 4). One sample (NL247-13) has relatively flat $LREE_N$-$HREE_N$ with La_N/Ho_N of 0.9 (Figure 4). In three samples where both Tb and Lu were above the LOQ, the $MREE_N$-$HREE_N$ are relatively flat with Tb_N/Lu_N = 0.8–1.4. The majority of samples show enrichments in Zr and Hf, when normalized to primitive mantle (Figure 4).

3.4. Carbon and boron isotope composition of blue diamonds

Average carbon isotope values for our suite of blue diamonds are given in Table 1, and the full dataset is given in Data S3. The carbon isotope composition of individual samples is homogeneous, with within-sample variation ranging from 0.09 to 1.5 ‰ 2σ.

Carbon isotope values vary considerably across our sample suite ($\delta^{13}C$ of −20.6 to −1.8 ‰; Data S3), consistent with previously published $\delta^{13}C$ for six Type IIb diamonds (spanning −20.8 to −1.8 ‰; Milledge et al., 1983; Smith et al., 2018). Carbon isotope values for blue diamonds are similar to the range for eclogitic diamonds from the lithospheric mantle (Figure 5). However, unlike worldwide eclogitic diamonds, blue diamonds do not display a mode at the canonical mantle value of −5 ‰ (Figure 5). The absence of a $\delta^{13}C$ mode at −5 ‰ is also seen in sublithospheric diamonds with majoritic garnet inclusions, which crystallize from carbonate-rich slab melts (Thomson et al., 2016b; Regier et al., 2020).

Boron isotope data for blue diamonds are given in Table 1 and in Data S4. Blue diamonds have a range of $\delta^{11}B_{SRM951}$ values from −9 to 0 ‰ ($n = 11$; Figure 6). No correlations between $\delta^{13}C$ and $\delta^{11}B$, or between $\delta^{11}B$ and B concentration were observed in our samples (Figure 6).

4. Discussion

4.1. Blue diamond formation – evidence from mineral inclusions

Given the presence of enstatite and Ca-silicate (touching breyite + larnite) inclusions in a single diamond (Blue2; Table 1), the simplest interpretation is that these minerals were originally entrapped as bridgmanite ($MgSiO_3$) and $CaSiO_3$-perovskite in the lower mantle. However, the Ca-silicate inclusions in our study and in Smith et al. (2018), lack Ca-poor, titanite-structured $CaSi_2O_5$. It is possible that the Ca-silicate inclusions contain a $CaSi_2O_5$ phase that was not detected by Raman or Synchrotron XRD, which would bring the bulk inclusion stoichiometry in line with an original $CaSiO_3$ stoichiometry.

Alternatively, it is possible that the observed co-existing breyite ($CaSiO_3$) and larnite (Ca_2SiO_4) phases represent a bulk inclusion composition with a Ca/Si ratio greater than 1 (Brenker et al., 2005). In this case, the inclusion cannot represent retrogression of an initial single-phase $CaSiO_3$- perovskite inclusion, and must be derived from a substrate with Ca/Si ratios higher than pyrolite, which has Ca/Si of ~0.1 (Ringwood, 1975).

In the case of primary two-phase (Ca_2SiO_4–$CaSiO_3$) inclusions, high Ca/Si ratios could originate in either of the following environments: 1) carbonatitic melts of carbonate-rich oceanic slabs (Ca/Si ~25; Pal'yanov et al., 2013); 2) serpentinized peridotite, where serpentinization can remove Si and also create Ca-enriched rocks such as rodingites. Both of these scenarios require a slab-influenced lower mantle crystallization environment for the blue diamonds.

The reduced Fe-Ni rich alloys, preserved as rims around the Ca- and Mg-silicate inclusions (Figure 2), resemble those reported in CLIPPIR diamonds (Cullinan-Like, Inclusion Poor, Pure, Irregular, Resorbed; a variety of sublithospheric diamonds comprising many large, gem-quality Type IIa diamonds) that have iron isotope signatures similar to metallic precipitates in meta-serpentinite (Smith et al., 2016, 2021). Together, the mineral inclusions in our suite of blue diamonds suggest crystallization in an environment similar to CLIPPIR diamonds, i.e., near the boundary of the transition zone and lower mantle.

4.2. Blue diamond formation – evidence from the trace element and isotope composition of diamond

Further evidence in support of a slab-influenced crystallization environment for the blue diamonds and their inclusions is provided by trace element and boron isotope measurements of the diamonds themselves.

Zr-Hf enrichments in primitive mantle-normalized trace element patterns demonstrate that the boron-bearing fluids could not have derived from carbonated peridotite or other carbonate-bearing lithologies (sediment, altered oceanic crust) in the oceanic lithosphere. Carbonatites and kimberlites are characteristically depleted in Zr-Hf (Nelson et al., 1988; Giuliani et al., 2020), and sublithospheric diamonds from Brazil that have an inferred carbonatitic origin (Walter et al., 2011; Thomson et al., 2016a) exhibit Zr-Hf depletions in their primitive mantle-normalized trace element abundances (Timmerman et al., 2019). Other diamonds that have Zr-Hf enrichments and relatively flat $MREE_N$-$HREE_N$ are Victor monocrystalline diamonds (Krebs et al., 2019), Marange methane-bearing diamonds (Smit et al., 2016, Smit et al., unpublished data) and CLIPPIR diamonds (Smit et al., unpublished data). In the case of the Marange diamonds, reduced hydrous fluids derived from serpentinized peridotite were implicated in their formation (Smit et al., 2016a), and in the case of CLIPPIR diamonds, the Fe isotope signatures of Fe-Ni-C-S melt inclusions indicate derivation from meta-serpentinite (Smith et al., 2021).

The range of boron isotope values in our blue diamonds (−9 to 0 ‰) is far more variable than that of the convecting mantle as represented by the depleted mid-ocean ridge basalt (MORB)-source mantle (−7.1 ± 0.9 ‰) (Marschall et al., 2017). Blue diamonds have boron isotope compositions that range from indistinguishable from MORB to higher values that overlap the range for metamorphosed serpentinite and altered oceanic crust (AOC), and strongly implicate a seawater-altered slab source for the boron (Figure 7).

The measured boron values of the Cullinan blue diamonds are lower than highly metamorphosed sediments and altered oceanic crust (AOC) in the diamond stability field. This is because these lithologies experience large degrees of fluid and ^{11}B loss during subduction-related dehydration (Figure 7A). For instance, models of boron loss during subduction indicate that sediments and AOC lose >90 % of their boron at sub-arc mantle depths (Konrad-Schmolke & Halama, 2014). The remaining boron has $\delta^{11}B$ of ≤ −10 ‰ at 2.5 GPa (Marschall et al., 2007), and ≤ −15 ‰ at 5 GPa (Konrad-Schmolke & Halama, 2014). Thus, while the $\delta^{11}B$ values of blue diamonds are unambiguously indicative of a seawater-altered slab source, the boron we measure in these blue diamonds is unlikely to derive from the sedimentary or crustal sections of subducting slabs.

While there are very few published B isotope analyses for eclogites, existing data indicate a boron-poor, ^{11}B-depleted nature of subducted and dehydrated AOC and sediments. Thus, an alternative reservoir in the slab is required to produce blue diamonds that can contain up to 8 μg/g B (Gaillou et al., 2012) and $\delta^{11}B \leq 0$ ‰. One plausible source is oceanic slab serpentinite, a significant ^{11}B sink (Martin et al., 2020), with $\delta^{13}C$ overlapping the range of our blue diamonds (Figure 5). The seawater-derived ^{11}B-enriched signature of serpentinite is retained under higher pressure conditions at 3−5 GPa (Martin et al., 2020, and Figure 7A), though the extreme values of the protoliths are moderated by fractionation on B loss, as indicated by modelling (Cannaò, 2020). Such fractionated B isotope ratios likely persist into the transition zone and deeper if the serpentine recrystallizes into dense hydrous magnesium silicates (DHMS) along cool slab trajectories (Scambelluri & Tonarini, 2012) or into metamorphic olivine (de Hoog et al., 2014; Cannaò, 2020) which stores boron as the hydrous component Mg_2BO_4H (Ingrin et al., 2014).

For typical slab P-T paths (Figure 8), a number of boron-bearing, high-pressure phases – including ringwoodite, DHMS Phase D and superhydrous Phase B – are likely to destabilize near the upper mantle-lower mantle boundary (Ohtani et al., 2000, 2001; Harte, 2010; Nishi et al., 2014; Cannaò, 2020; Shirey et al., 2021). On the basis of mineral inclusions, this is the region proposed for blue diamond formation (this study; Smith et al., 2018). These phases provide multiple opportunities for transporting seawater-derived boron into the deep mantle. While the B isotope composition of newly formed diamonds is unlikely to be exactly transposed from the protoliths, it seems clear that there is a high likelihood of inheriting a wide range of B isotope compositions that will extend to considerably higher values than MORB.

4.3. Model for the formation of blue diamonds

There are four observations and associated interpretations that need to be reconciled in any model for blue diamond formation:

(1) High Ca:Si ratios in the inclusions; suggesting formation in either a carbonatitic melt or an unusual source rock.

(2) Elevated Zr and Hf contents in diamond, which is evidence against carbonatite melt as the diamond-forming medium, although we cannot rule out carbonate being present in the earlier prograde subduction path.

(3) ^{13}C-depleted carbon isotope compositions, down to $\delta^{13}C = -21$ ‰, that require carbon input from biogenic carbonate or former organic matter (stored as diamond, carbides or in metal).

(4) Boron isotope compositions ($\delta^{11}B = -9$ to 0 ‰) that vary from MORB-like to significantly more ^{11}B-enriched than MORB mantle (DMM; Marschall, 2018), and likely derived from metaserpentinite (consistent with Fe isotope compositions reported for some sublithospheric diamonds; Smith et al., 2021).

To satisfy the constraints from boron isotopes, any boron-bearing medium for diamond formation is likely derived directly or indirectly (as fluids) from metaserpentinites. In order to not lose boron entirely during early dehydration stages of the slab, the metaserpentinite that serves as the source for boron-containing diamonds needs to be stored in the deeper inner portions of the slab (Shirey et al. 2021).

Below we consider three different rock types – metarodingite, metabasalt, and metaserpentinite – that may act as substrates or fluid sources for the formation of blue diamonds and evaluate each with respect to inclusion Ca:Si ratios, the source of ^{13}C-depleted carbon, and the Zr-Hf evidence against a carbonatitic diamond-forming medium. We note that any environment for blue diamond formation must be fairly uncommon/unusual in order to account for the rarity of blue diamonds (less than 0.02 % of mined diamonds, and less than 2% of sublithospheric diamonds; Smith et al., 2018).

Metarodingite substrate. Rodingites are Ca-rich metasomatic rocks formed by alteration of mafic to ultramafic rocks. In the oceanic lithosphere and subducting slabs, (meta)rodingites occur at the interface between serpentinite and AOC (gabbro) or as lenses in serpentinite, where their formation relates to Ca-rich fluids released from serpentinite. Metarodingites are rich in boron – Kobayashi & Kaneda (2010) report vesuvianite from rodingite with up to 1 wt% B_2O_3 – and have elevated Ca/Si.

For metarodingite to be a plausible environment for blue diamond formation, an external carbon source is required to provide ^{13}C-depleted carbon. Such carbon is unlikely to derive from melting of biogenic carbonates, as this cannot be reconciled with the elevated Zr-Hf contents in the diamond; and carbon derived from metaperidotite is unlikely to be ^{13}C-depleted. A plausible alternative for the carbon source is oxidative dissolution of former organic matter (stored as diamond, in metal or as carbides), before the carbon-bearing fluid reaches the deeply subducted metarodingite. However, as rodingite is a garnet-rich rock, with bulkrock Al_2O_3 contents that can exceed 30 wt%, blue diamonds forming in a metarodingite environment may be expected to have abundant majoritic garnet inclusions, or inclusions of other highly aluminous phases, which we do not observe in our suite of blue diamonds.

Verdict: We consider a metarodingite environment to be an unlikely environment for blue diamond formation. This environment can explain the generation of boron-rich rocks with elevated Ca/Si, however, it cannot be reconciled with the lack of abundant majoritic garnet inclusions in blue diamond and requires and external carbon source that typically is located at shallower levels in the AOC.

Metabasalt substrate. In this model, boron-bearing hydrous fluids from dehydrating serpentinite react with metamorphosed AOC. Within the AOC, the localized environment for diamond formation must be Ca-rich (high Ca:Si), for example through the presence of residual secondary carbonate. The serpentinite-derived fluid must be reducing enough to produce diamond from any carbonate present and transfers boron through interaction with this crust.

Verdict: We could consider metabasalt a plausible environment for blue diamond precipitation from serpentinite-derived fluid. This environment is consistent with the observed Ca:Si ratios (residual carbonates in the metabasalt), the non-carbonatitic diamond-forming media (fluid derived from metaserpentinite), the ^{13}C-depleted carbon isotope compositions (residual carbon in metabasalt), and the boron isotope distribution (metaserpentinite). The origin of trace element patterns with positive Zr-Hf anomalies is not clear in this model.

Metaserpentinite substrate. In this model, diamond grows in metaserpentinite, where the subducted boron is hosted as a consequence of seawater alteration, rather than transported through a percolating fluid into a second lithology. In the metaserpentinite model, we need to reconcile the high Ca:Si ratios in the inclusions and we require an external carbon source for the ^{13}C-depleted carbon isotope compositions. Accordingly, we consider three possibilities:

a) Conductive warming of the slab causes melting of residual slab carbonates (see phase equilibria and geotherms presented in Shirey et al., 2021). This carbonated melt moves inwards to colder regions and carries ^{13}C-depleted carbon isotope compositions, i.e., the melt originates from the crustal (AOC) portion of the slab. In a buckled or imbricated slab/megalith situation, former oceanic crust can easily lie below former lithospheric mantle. However, blue diamond formation from carbonatitic melts is precluded based on the Zr-Hf elevations observed in the primitive-mantle normalized trace element patterns, and carbonatitic melts can only explain the high Ca:Si ratios if high quantities of melt were involved.

b) Ophicalcite veins in metaserpentinites could explain the observed high Ca:Si ratios, but such ophicalcite veins have never been observed to have ^{13}C-depleted signatures and typically have $\delta^{13}C$ greater than 0 ‰ (Bach et al., 2011; Alt et al., 2013).

c) Disseminated carbonate can make up to 40 % of serpentinites and could readily explain the elevated Ca:Si ratios. The carbon in serpentinites is likely homogenized by the time it arrives in the deep transition zone and potentially forms part of a megalith at the transition zone-lower mantle boundary (660 km), so different carbon components are likely not relevant but only ’total carbon’ needs to be considered. There are no data on $\delta^{13}C$ for serpentinites from deep suboceanic lithospheric mantle. The only data reported are for tectonically-emplaced serpentinized peridotites in shallow oceanic crust. The total carbon in serpentinites (without calcite veins) often has $\delta^{13}C$ values extending below −20 ‰ (e.g., Alt et al., 2013, and Data S3). For example, serpentinite from Lost City (Mid Atlantic Ridge) has a $\delta^{13}C$ distribution from −23.0 to −1.0 ‰ with a median of −13.2 ‰ (Delacour et al., 2008), which provides a good match for the carbon isotope composition in our suite of blue diamonds (Figure 5). Diamond formation in deeply subducted, carbonated metaserpentinites may occur through either physical mixing with adjacent metal-saturated metaperidotites or ingress of reducing dehydration fluids derived from deeper within the slab.

Verdict: We consider a metaserpentinite environment, with disseminated carbonates, as the most likely environment for blue diamond formation. This environment can explain all our key observations: the high Ca:Si ratios in inclusions (disseminated carbonate), the non-carbonatitic diamond-forming media (diamond-forming fluid is derived locally, from metaserpentinite), the ^{13}C-depleted carbon isotope compositions of blue diamonds (carbon in metaserpentinites), and the range of boron isotopes in blue diamonds (metaserpentinite). Unlike diamond formation in a metabasalt substrate, the metaserpentinite-derived fluids can precipitate blue diamonds *in situ*, rather than percolate into another lithology for diamond formation. The unresolved question is if, in cold subducting slabs, serpentinite bodies tectonically emplaced into AOC can retain their carbon and boron contents to transition zone and lower mantle depths. Due to low Na contents, carbonate melting in metaserpentinites may be inefficient. But complete dehydration should efficiently remove boron, unless it is transferred into newly formed phases other than wadsleyite and ringwoodite. In detail, boron loss and gain in subducting oceanic lithosphere is complex, with no B loss observed in some metaserpentinites, possibly due to B influx from fluids derived from breakdown of B-bearing phases in metasediments (Harvey et al., 2014; Clarke et al., 2020). Although the mechanisms for boron transport remain unclear, our results from blue diamonds with recycled carbon and boron isotope signatures, provide the evidence that these elements can indeed be retained to transition zone and lower mantle depths. Since the boron distribution in blue diamonds does not match the full range of B observed in serpentinites, this suggests that the majority of boron was likely lost – as expected during prograde subduction. The fractionation of B isotopes due to hydrous phase breakdown is potentially mediated to mildly positive values by alkaline fluids created from carbonates in the early prograde subduction history (see modelling in Cannaò, 2020). The transport of boron to lower mantle depths in Earth is consistent with the ability of cold subducted slabs to deliver other volatiles such as water and carbon to these depths, as shown by the thermal modelling of slab paths in the context of hydrous phase equilibria and the generation of lower mantle diamonds bearing crustal carbon isotope signatures (Shirey et al., 2021; Walter et al., 2022). In this model, no carbonate-bearing melt is generated during diamond formation, consistent with the trace element systematics.

4.4. Deep subduction of serpentinized oceanic lithosphere

There is a striking similarity between the boron isotope composition of blue diamonds and those of mantle carbonatites and ocean island basalts (OIB) that are free of late-stage crustal contamination (Figure 7B), which we define here as those with 0.04 to 4.0 μg/g B (Chaussidon & Marty, 1995; Tanaka & Nakamura, 2005; Hulett et al., 2016; Çimen et al., 2018, 2019; Walowski et al., 2019). Given these two types of magmas have long been shown to contain recycled lithospheric components in their source regions (Hofmann, 1997; Hoernle et al., 2002), we suggest that deep-seated carbonatite and possibly OIB magmatism tap a reservoir that was contaminated by the same slab-derived components that contributed boron to lower mantle-derived blue diamonds. The blue diamonds from Cullinan, which must have crystallized prior to kimberlite eruption at ∼1.1 Ga (Kjarsgaard et al., 2022), may have experienced ambient mantle temperatures ∼100 °C higher than present (Vlaar et al., 1994). At these temperatures, even the coolest slabs would likely warm to temperatures above the stability of DHMS at uppermost lower mantle depths. This implies that a significant fraction of subducting slabs would have experienced melting of carbonated metabasalt in the transition zone (Thomson et al., 2016b), along with dehydration and associated mobilization of carbonates in metaserpentinite in the uppermost lower mantle, before penetration into the deep lower mantle. While this depletion may have acted as a barrier to volatile subduction and kept the deeper portions of the lower mantle relatively pristine and isolated from incompatible and volatile-rich components in the upper portions of slabs (Figure 9A,B), the lower mantle derived blue diamonds from Premier, erupted at ~ 1.1 Ga, imply that even in this situation, some recycled volatiles made their way at least to the uppermost lower mantle.

Secular cooling of Earth's mantle has likely allowed a greater proportion of modern-day subducting slabs to remain within the stability field of DHMS, including phase H (Figure 8), which is stable to depths greater than 1250 km along cool subduction geotherms (Nishi et al., 2014). Thus, in a cooler modern mantle, hydrous phases may better survive subduction into the deep lower mantle, beyond a depth of 660 km (Figure 9C, D), compared with the pre-Phanerozoic Earth. Intriguingly, mantle-derived carbonatites may only have become systematically ^{11}B-enriched in the recent geologic past (< 250 Ma), around the same time that deep-seated kimberlites begin to show significant slab input to their sources (Hulett et al., 2016; Woodhead et al., 2019). We suggest that these isotopic deviations in deep-seated Mesozoic magmas may reflect the point at which sufficient cooling of the ambient mantle permitted slabs to translate their incompatible element and volatile cargo into the deep lower mantle. The view of the lower mantle boron cycle provided by blue diamonds thus not only highlights the strict thermal and temporal constraints on the formation of Earth's most valuable diamonds, but also identifies seawater-altered serpentinite as a reservoir for chemically diversifying the mantle sources of Earth's deepest-derived melts.

5. Conclusions

We present new boron isotope and concentration data for a rare suite of sublithospheric boron-bearing blue diamonds. They contain seawater-derived boron that must have been subducted to transition zone to lower mantle depths prior to eruption of the Premier kimberlite 1.1 billion years ago. The diamonds have very negative $\delta^{13}C$ values that indicate a recycled carbon source.

The range in $\delta^{11}B$ values in blue diamonds does not show the full range of boron observed in serpentinites, likely due to boron loss due to the heating and devolatilization of subducting slabs, with the majority of boron lost in dehydration fluids. The boron isotope compositions of these blue diamonds range from MORB-like to values that are clearly higher, spanning the same range as metamorphosed serpentinized oceanic lithosphere. Only subducting slabs with the coolest PT paths should retain boron, water and carbon to lower mantle depths. This clear view that recycled boron reaches the transition zone and lower mantle requires re-evaluation of the mechanisms through which boron is transported to these depths.

A similar range of boron isotope signatures to those found in blue diamonds are also found in OIBs and carbonatites. This provides compelling evidence that deep volatile transport by the subduction of serpentinized oceanic lithosphere is essential not only for the formation of highly valuable blue diamonds, but also for the chemical diversity found in Earth's deeply derived intra-plate magmas.

CRediT authorship contribution statement

The analytical work was completed by M.E. Regier, R.A. Stern, T.B. Chalk, G. L. Foster, and C. Debuhr. Samples were provided by A. Burnham, E.M. Smith and J.W. Harris. This paper is based on M.E. Regier's PhD thesis. All authors contributed ideas and writing to the manuscript.

Declaration of competing interest

Authors declare no competing interests.

Data availability

All data are available in the main text or the supplementary materials.

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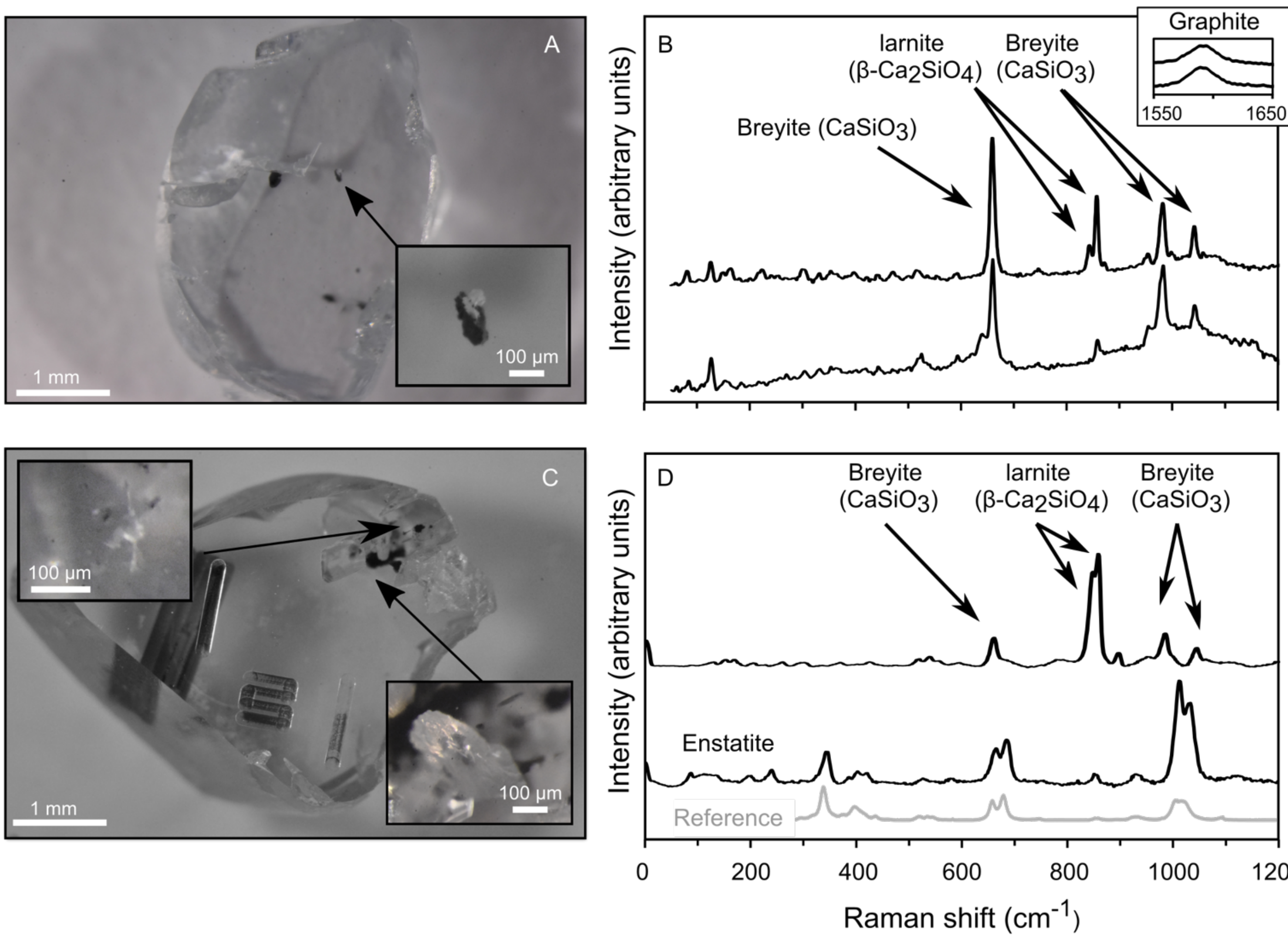

Figure 1: Optical photographs and Raman spectra of inclusion-bearing blue diamonds. (A) Photo of sample NL247-2 and a high magnification inset of a selected mineral inclusion. The black ring around the inclusion is composed of an Fe-Ni rich alloy and graphite as determined by µXRF (Figure 2) and a broad Raman peak at 1580 cm^{-1} (inset). (B) Raman spectra from two bimineralic Ca-silicate inclusions including larnite and breyite. Note that the prominent peak for Ca-poor $CaSi_2O_5$-titanite phase at ~355 cm^{-1} is absent in these spectra and in the inclusions reported by Smith et al. (2018). (C) Optical photo of Blue2 with an inset of bimineralic Ca-silicate (top) and enstatite (bottom) inclusions. Dark patterns on the surface of diamond are laser ablation tracks. (D) Selected Raman spectra for inclusions in sample Blue2, including a bimineralic Ca-silicate inclusion, an enstatite inclusion, and a reference enstatite spectrum from the RRUFF database (Lafuente et al., 2016). The $CaSi_2O_5$-titanite phase is also absent from the Ca-silicate spectrum in this sample. Raman spectral data available in data S1.

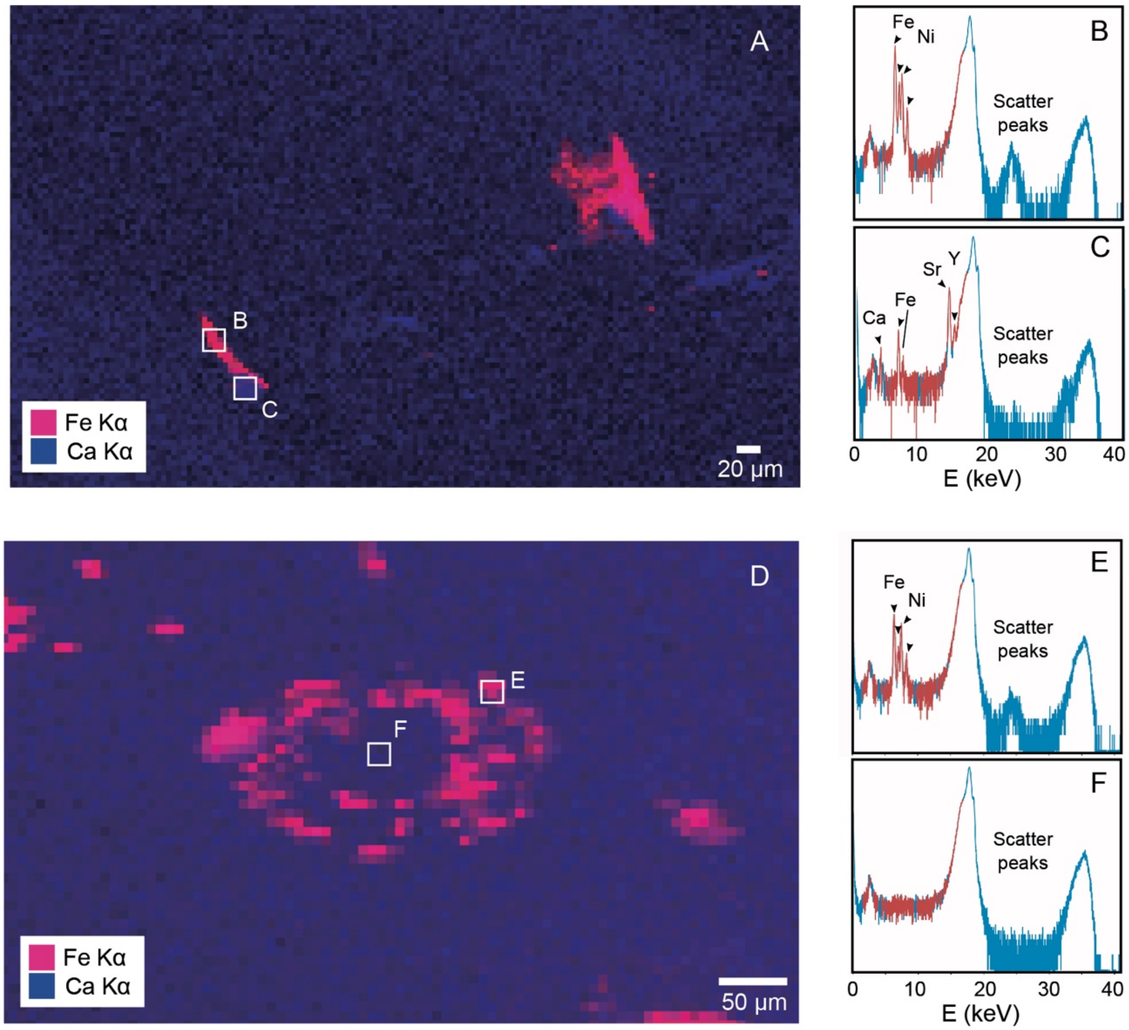

Figure 2: µXRF data from GSECARS 13-IDE for diamonds Blue2 and NL247-2. (a) Image of Ca-silicate inclusion in diamond NL247-2 with Fe-Ni rich alloy rims. (b) Rim around inclusion is Fe-Ni-rich. Peaks that are not identified are analytical background features due to Bremsstrahlung and x-ray scattering. (c) Ca, Fe, Sr, and Y are visible in the spectra of the Ca-silicate inclusion. (d) Image of enstatite inclusion in Blue2. The central enstatite inclusion appears dark blue due to its low Fe content, but it is identifiable due to the surrounding Fe-Ni rich rim. (e) Fe and Ni spectral peaks are visible around inclusion. (f) Enstatite inclusion shows no visible spectral peaks in this range.

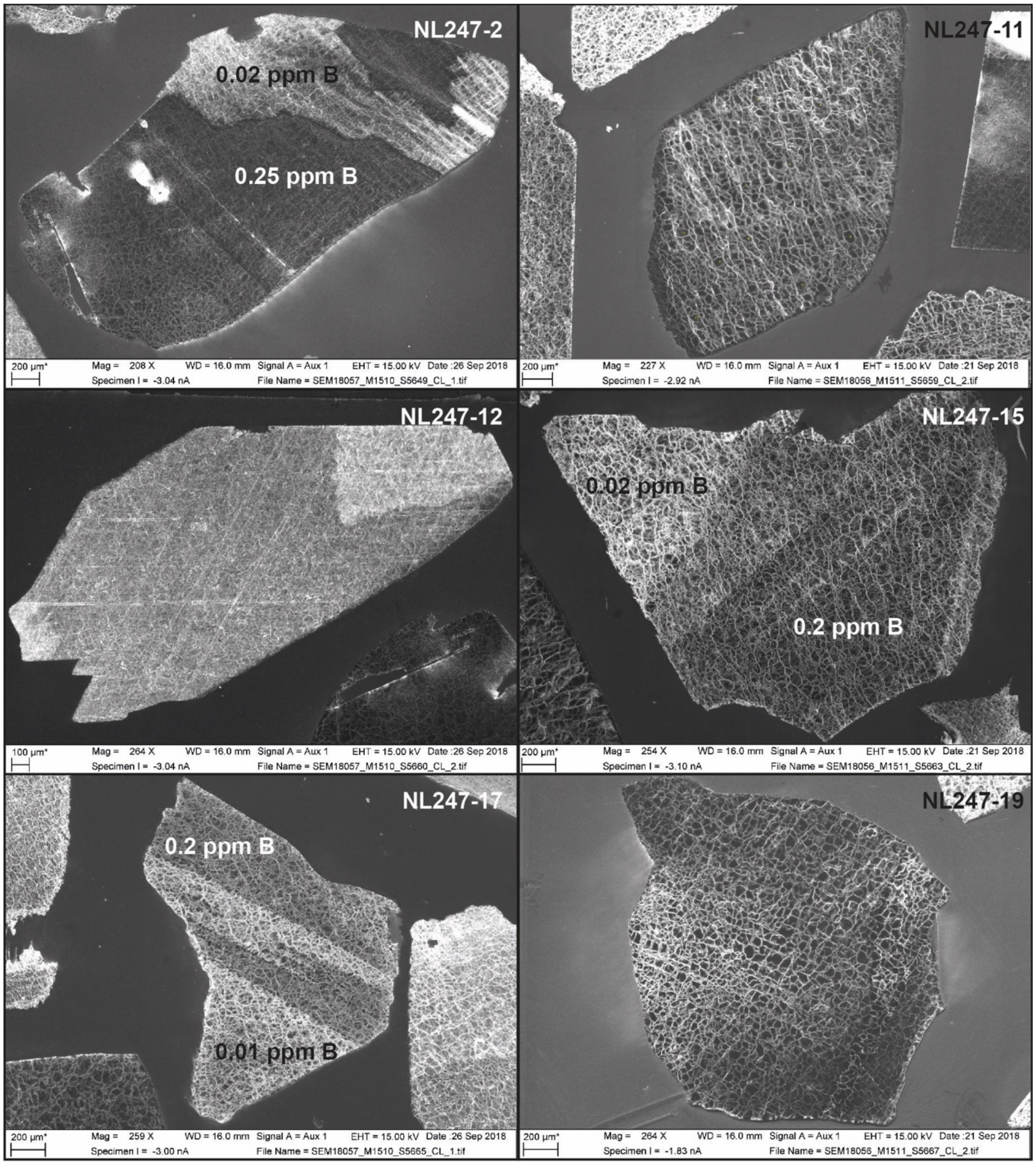

Figure 3: Representative panchromatic cathodoluminescence (CL) images of Type IIb diamonds. All samples have CL emissions which show dislocation networks that form during diamond deformation in the deep Earth. A few samples show luminescence zoning that is inversely correlated with boron concentration. Where distinct zones are visible, boron concentrations are shown.

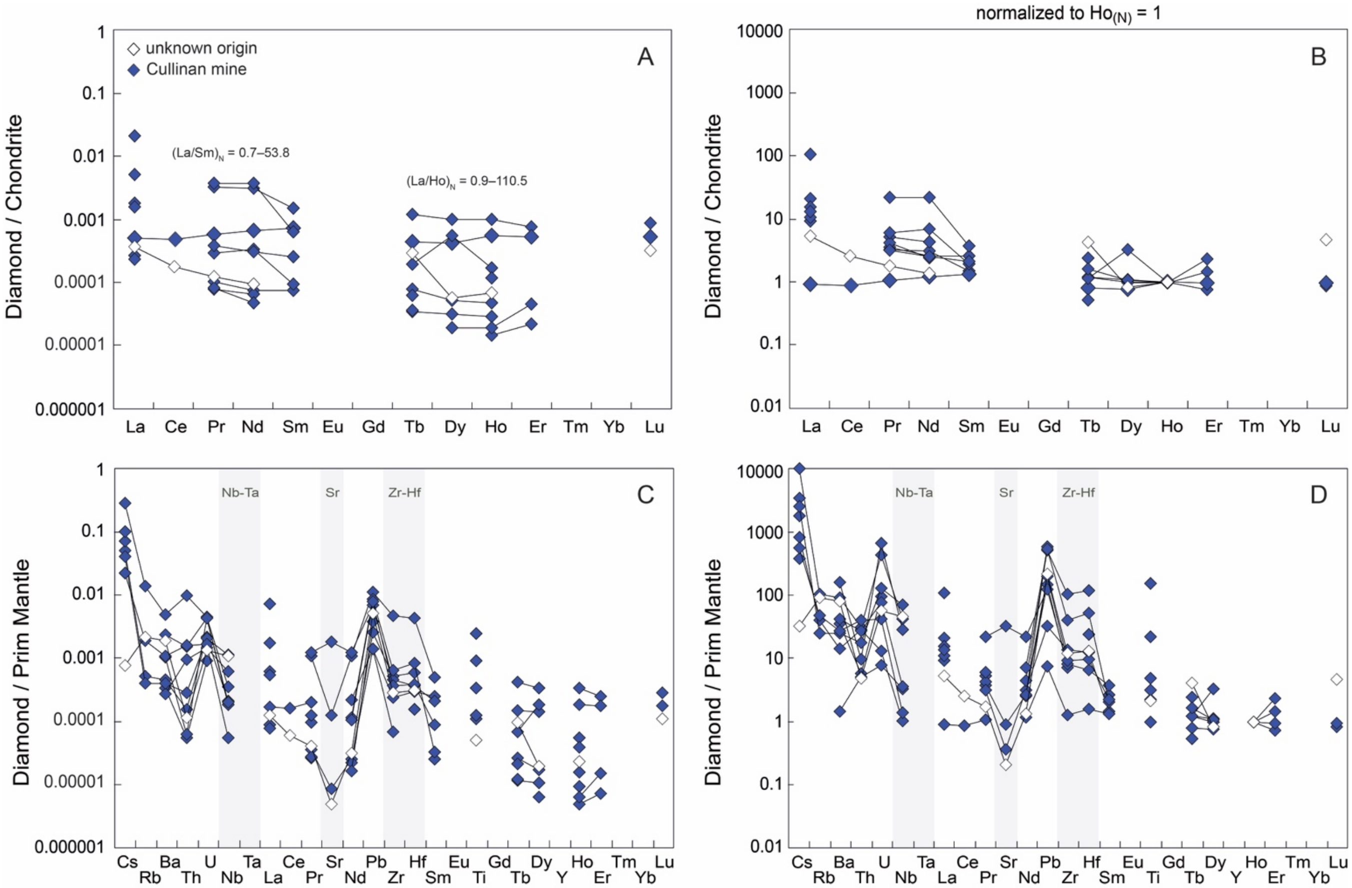

Figure 4: A and B) Rare earth element concentrations of blue diamonds, normalized to CI chondrite (Sun & McDonough, 1989). C and D) Trace element concentrations of blue diamonds, normalized to primitive mantle (Sun & McDonough, 1989). B and D are double-normalized to $Ho_N = 1$ because elemental concentration is a function of nano-sized inclusion density. Only data above the limit of quantification (LOQ; blank + 7σ) are plotted.

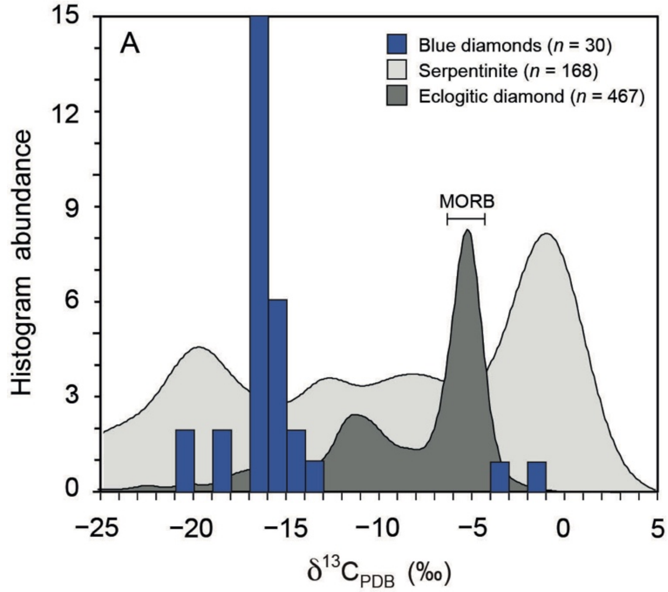

Figure 5: Carbon isotope histogram for blue diamonds compared to probability density functions for eclogitic diamonds and serpentinite from ophiolites, ultramafic complexes, and active peridotite-hosted hydrothermal systems (Data S3). Analytical precision (2σ) is ∼0.1 ‰ for blue diamonds. The histogram mode at approx. −17 ‰ may be an artefact due to oversampling of diamonds from one source. Density function bandwidth is 1.5 ‰ for serpentinite and 0.7 ‰ for eclogitic diamonds. Range of $\delta^{13}C$ for mid-ocean ridge basalt (MORB) source mantle indicated by bar at approx. −5 ‰ (Marty & Zimmermann, 1999).

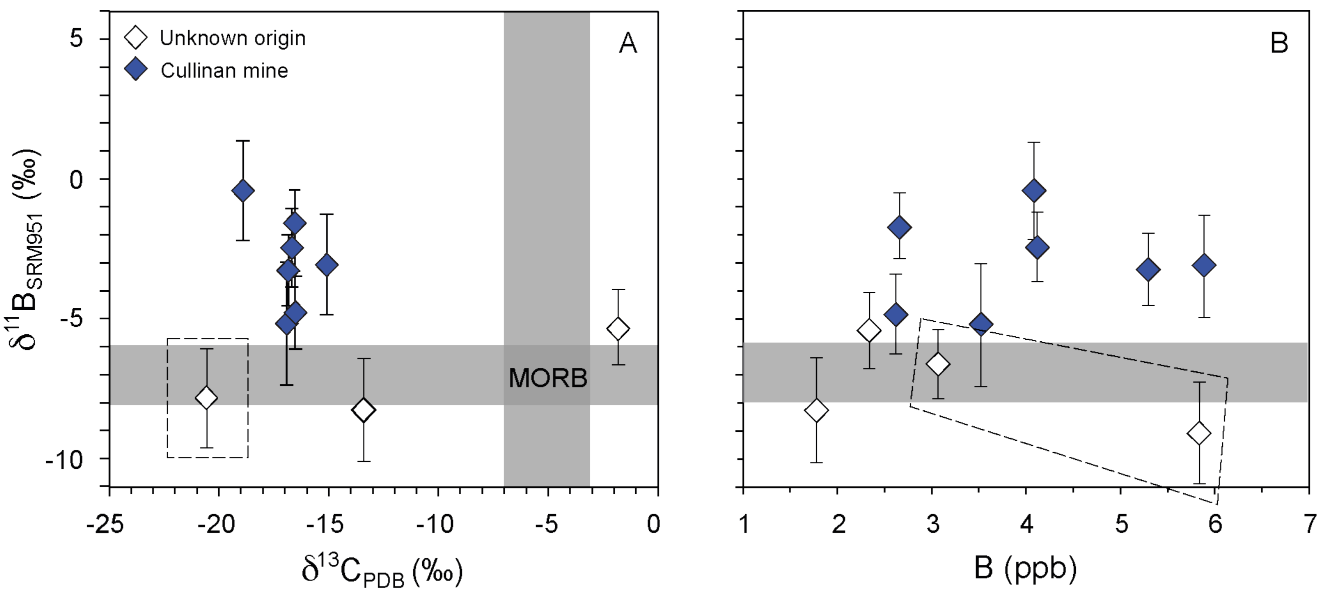

Figure 6: Boron and carbon isotope and concentration data of blue diamonds. (a) $\delta^{11}B$ vs. $\delta^{13}C$ of blue diamonds from Cullinan mine and those of uncertain origin. Mid-ocean ridge basalt (MORB) is indicated in grey field (Marschall, 2018). (b) Measured $\delta^{11}B$ vs. the concentration of B in the solution (not normalized to boron concentration in diamond). Although the B concentration of the solution has no correlation with B concentration of the diamond, it is useful to assess that there is not a change in measured B isotopic composition with B concentration. The dashed lines enclose repeat analyses on different sides of the same stone.

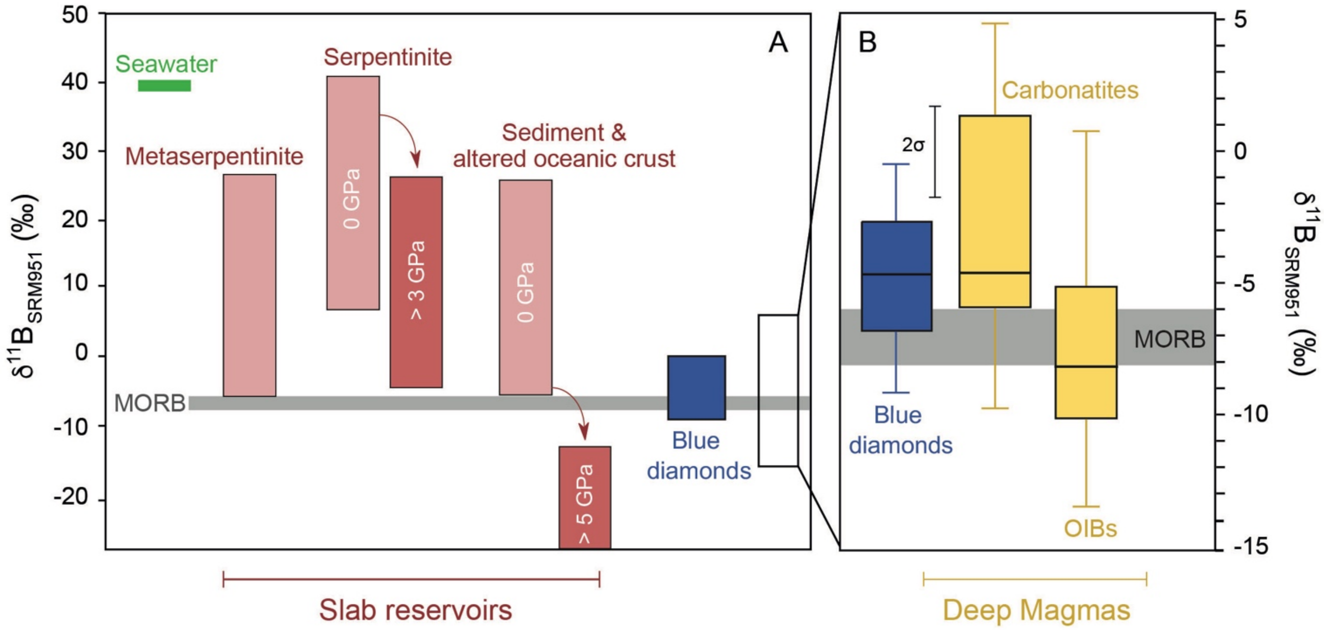

Figure 7: Boron isotope signature of blue diamonds, slab reservoirs, deeply derived magmas, seawater, and typical upper mantle. Typical upper mantle (grey bars) is represented by mid-ocean ridge basalts (MORB; −7.1 ± 0.9 ‰; Marschall, 2018). (A) $\delta^{11}B$ of blue diamonds is compared to ranges for seawater, slab serpentinite, and sediments + altered oceanic crust (AOC). Field for metaserpentinite is from the Cerro del Almirez massif that experienced metamorphism to eclogite-facies conditions (Harvey et al., 2014). The arrow for serpentinite indicates the isotopic evolution during subduction for present-day abyssal serpentinites (Martin et al., 2020), to modeled post-serpentinite phases at >3 GPa (Cannaò, 2020). The arrow for sediment + AOC indicates the isotopic evolution from surface (Data S5) to modeled metasediment and meta-AOC at > 5 GPa (Konrad-Schmolke & Halama, 2014). (B) Box and whisker plot for $\delta^{11}B$ of blue diamonds (n = 11; this study), ocean island basalts (OIBs; n = 48) and carbonatites (n = 23; data S5). The typical analytical uncertainty (indicated by the 2σ bar) for blue diamonds includes propagated uncertainty from repeat analysis of secondary reference materials.

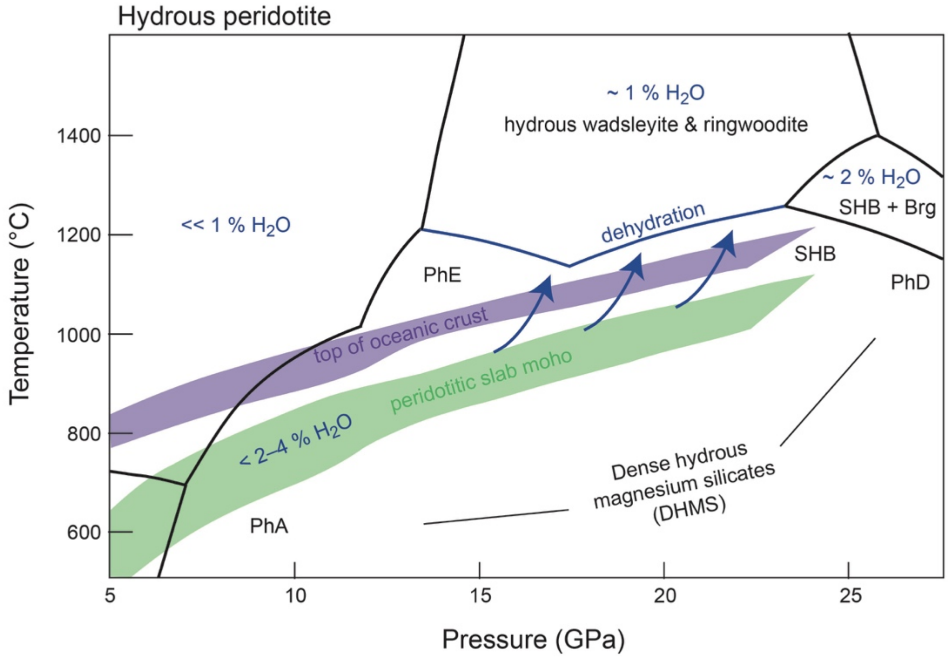

Figure 8: Stability of hydrous meta-peridotitic phases including ringwoodite, wadsleyite, bridgmanite (Brg), and dense hydrous magnesium silicates (DHMS) phases – Phase A (PhA), superhydrous phase B (SHB), phase E (PhE), phase D (PhD). Overlaid on this phase diagram are pressure-temperature (PT) pathways for subducting slabs calculated from deep earthquake seismicity (taken from Shirey et al., 2021): the purple PT pathway represents basaltic lithologies to the top of the oceanic crust, and the green PT pathway represents peridotite mantle lithologies at the slab Moho. Peridotite in subducting slabs can transport water, hosted in DHMS phases, down to the transition zone. As slabs stall and warm up at the transition zone, breakdown of DHMS phases produce H_2O-rich fluids for diamond formation (blue arrows). Figure is modified from Iwamori (2004) and Shirey et al. (2021).

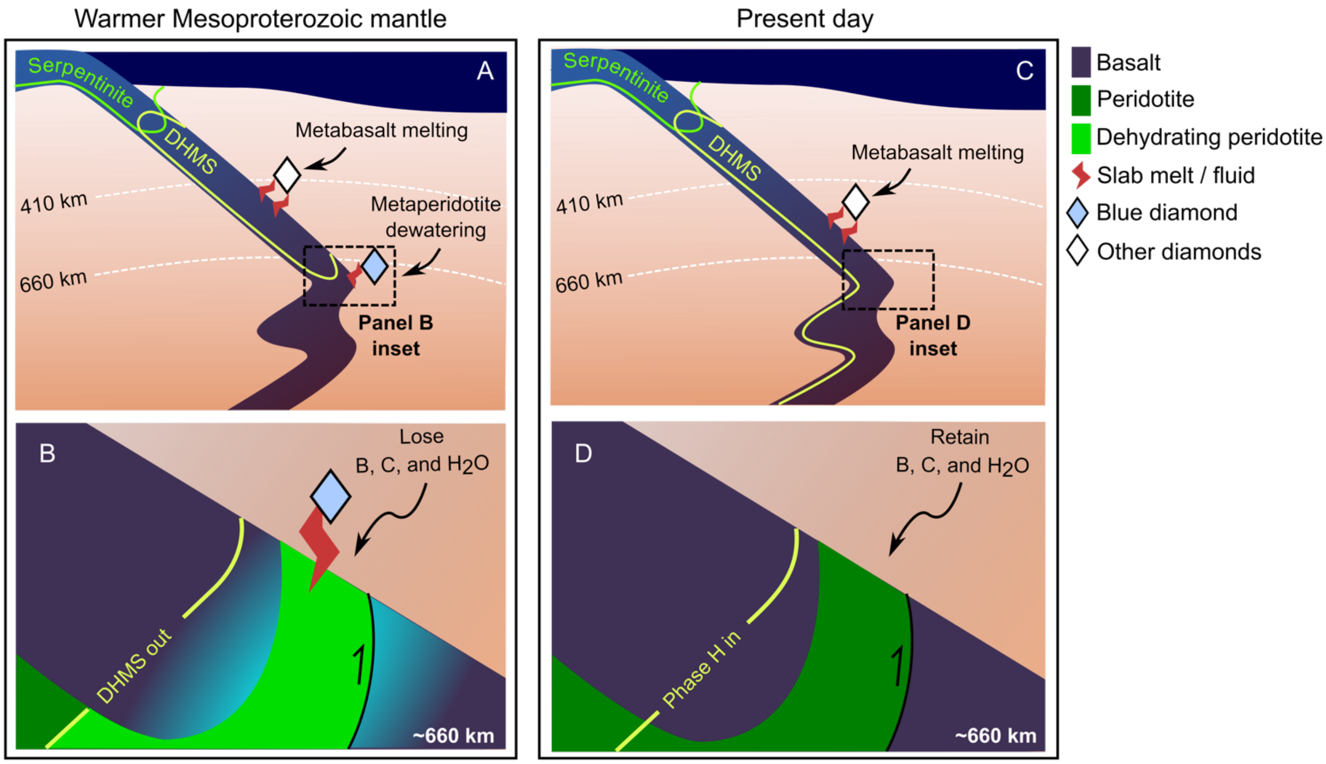

Figure 9: Potential modes for the transfer of slab volatiles to the deep Earth in relatively cool slabs in the ancient- and current-day mantle. (A) Cross-section of the mantle depicting a relatively cool slab subducting into the lower mantle. Phase stabilities of serpentinite and dense hydrous magnesium silicates (DHMS), such as Phase H, are indicated in the slab. Formation of Cullinan blue diamonds in the Mesoproterozoic was likely influenced by somewhat higher mantle temperature (~100 °C; Vlaar et al., 1994) than the present-day mantle. At this time, many subducting slabs would produce boron-free diamond after crossing the carbonated metabasaltic solidus in the transition zone (Thomson et al., 2016b), and would also produce boron-rich diamonds during fluid release from metaserpentinite in the uppermost lower mantle. (B) Metaperidotite hosts substantial H_2O, C, and B, until the destabilization of DHMS ('DHMS out') in the Mesoproterozoic mantle. This release of hydrous fluids for blue diamond formation results in volatile and incompatible element-poor subducting slabs entering the deeper lower mantle. (C) While most slab tops will cross a carbonated metabasaltic solidus in the present-day mantle to produce boron-free diamonds, (D) high-pressure DHMS may be retained ('Phase H in') in the current-day deeper portions of the slab, allowing for the transfer of volatile and incompatible elements into the deeper lower mantle within DHMS-rich carbonated metaperidotite (Nishi et al., 2014; Scambelluri et al., 2019).

Table 1. Details of Type IIb diamonds analyzed in this study

Diamond	Comment	Origin	$\delta^{13}C$ (‰)	$2\sigma^{d}$	N (µg/g)	$2\sigma^{d}$	B^{e} (µg/g)	$2\sigma^{d}$	$\delta^{11}B$ (‰)	$2\sigma^{d}$
110208425476	Ferropericlase, olivine, nyerereite	unknown[a]	-	-	-	-	-	-	–5.35	1.38
DVBT	Breyite, Fe-Ni-S alloy	unknown[a]	-	-	-	-	-	-	–8.23	1.85
AB	cube-cut diamond	unknown[a]	–20.56	0.20	3.64	3.35	0.332	0.161	–9.24	1.96
			-	-	-	-	-	-	–6.57	1.29
Blue1	Inclusion-free	Cullinan[c]	–15.09	0.09	<0.35	-	0.127	0.018	–3.08	1.83
Blue2	Enstatite, breyite, larnite, Fe-Ni alloy	Cullinan[c]	–18.91	1.51	<0.35	-	-	-	–0.47	2.07
NL247-2	Breyite, larnite, Fe-Ni alloy	Cullinan[c]	–15.62	0.15	<0.35	-	0.111	0.238	-	-
NL247-3	Inclusion-free	Cullinan[c]	–16.90	0.14	<0.35	-	0.175	0.072	–3.23	1.30
NL247-4	Inclusion-free	Cullinan[c]	–16.83	0.09	<0.5	-	0.193	0.042	-	-
NL247-5	Inclusion-free	Cullinan[c]	–16.76	0.13	<0.5	-	0.055	0.167	-	-
NL247-6	Inclusion-free	Cullinan[c]	–16.68	0.13	<0.5	-	0.045	0.102	-	-
NL247-7	Inclusion-free	Cullinan[c]	–16.49	0.13	<0.5	-	0.202	0.049	-	-
NL247-8	Inclusion-free	Cullinan[c]	–16.87	0.10	<0.35	-	0.195	0.054	–5.19	2.24
NL247-9	Inclusion-free	Cullinan[c]	–14.63	0.44	<0.5	-	0.076	0.091	-	-
NL247-10	Inclusion-free	Cullinan[c]	–16.55	0.16	<0.5	-	0.149	0.131	–1.65	1.28
NL247-11	Inclusion-free	Cullinan[c]	–15.73	0.14	<0.5	-	0.142	0.112	-	-
NL247-12	Inclusion-free	Cullinan[c]	–15.34	0.12	<0.35	-	-	-	-	-
NL247-13	Inclusion-free	Cullinan[c]	–16.80	0.14	<0.5	-	0.241	0.145	-	-
NL247-14	Inclusion-free	Cullinan[c]	–15.85	0.23	-	-	0.120	0.248	-	-
NL247-15	Inclusion-free	Cullinan[c]	–16.60	0.27	<0.5	-	0.134	0.165	–2.43	1.26
NL247-16	Inclusion-free	Cullinan[c]	–16.81	0.22	-	-	0.136	0.260	-	-
NL247-17	Inclusion-free	Cullinan[c]	–16.87	0.24	<0.35	-	0.095	0.178	-	-
NL247-18	Inclusion-free	Cullinan[c]	–16.38	0.16	-	-	-	-	-	-
NL247-19	Inclusion-free	Cullinan[c]	–16.47	0.16	<0.5	-	0.201	0.166	–4.77	1.45
NL247-20	Inclusion-free	Cullinan[c]	–15.68	0.15	<0.5	-	0.185	0.008	-	-
NL247-21	Inclusion-free	Cullinan[c]	–16.54	0.13	<0.5	-	0.181	0.182	-	-
NL247-22	Inclusion-free	Cullinan[c]	–16.43	0.17	-	-	-	-	-	-
NL247-23	Inclusion-free	Type Ia Cullinan[c]	–4.70	1.06	330.34	282.05	0.002	0.006	-	-

[a] previously studied by Smith et al. (2018), [b] sourced from Antony Burnham, [c] sourced from Jeff Harris, [d] averaged values for each sample, with 2σ given as within-sample variability, [e] boron content determined by SIMS, with reference materials calibrated by hyperspectral CL.

Supplementary Text

Boron isotopes in blue diamond record seawater-derived fluids in the lower mantle

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1. Mineral inclusion study

Prior to any destructive analytical work, we collected Raman spectra and X-ray microfluorescence (μXRF) data from two diamonds (NL247-2 and Blue2). Confocal Raman spectra were collected at Northwestern University using a custom-built system with an Olympus BX microscope with a 100× or 50× objective and a Melles-Griot solid-state laser that produced ~8 mW power at the sample surface. Spectra were obtained for ~20 s and averaged over four or more accumulations. μXRF was completed at 13-IDE (GSECARS, APS, Argonne National Laboratory) using a primary beam of wavelength at 0.6199 Å (= 20 keV). The X-ray beam was focused to 2×3 μm^2 beam using a Vortex detector. Fluorescence maps (Figure 2 in the main text) were processed using the software package Larch v.0.9.44 (Newville, 2013). The results highlight the presence of Fe-Ni rich rims. Since low Z elements are not detectable using this method, we cannot determine if these alloys are carbides or sulfides, although both were previously documented (Smith *et al.*, 2018).

Electron probe microanalysis was completed on an inclusion that was recovered after breaking the enstatite-bearing corner of sample Blue2. The analyses utilized a JEOL JXA-8900R with five wavelength-dispersive spectrometers at the University of Alberta. The beam energy was 20 keV with 30 nA of beam current and 2 μm diameter. The counting time was 20 s for Si Kα, Fe Kα, Mn Kα, Ni Kα, Zn Kα, 30 s for V Kα, Ti Kα, Cr Kα, 40 s for Na Kα, K Kα, Ca Kα, Mg Kα, and 120 s for Al Kα. Results and standards are reported in Data S7.

2. Quantification of nitrogen, boron, and the carbon isotopic composition of blue diamonds

Diamonds were mounted in epoxy and/or indium for CL imaging and secondary ion mass spectrometry (SIMS) analysis at the Canadian Centre for Isotopic Microanalysis. CL imaging was completed using a Zeiss EVO MA15 scanning electron microscope (SEM), with a broadband photomultiplier detector, operating at 15 kV and 3–5 nA beam current. Carbon isotopes ($^{13}C/^{12}C$) and nitrogen abundances were determined in separate ion probe sessions using methods and reference materials that have already been detailed (Stern *et al.*, 2014).

Most of the diamonds in this study have exceedingly low N contents, such that background contributions due to residual gases in the analysis chamber were the limiting factor in determining the detection limits. For two sessions, one with and one without a liquid nitrogen cold finger, it was determined that the backgrounds were equivalent to ~0.35 μg/g and ~0.5 μg/g, respectively, and that all but one of the blue diamonds (sample AB) had nitrogen concentrations below these values.

Boron abundances in diamonds were determined by simultaneously measuring $^{11}B^-/^{12}C^-$ in an electron multiplier-Faraday cup (C-H1) combination over a 100 s counting interval using a Cs^+ beam of 1.5–2.0 nA. Mass resolution of >2000 easily resolved the isobar $^{10}BH^-$. Background count rates of $^{11}B^-$ based on analysis of a particular growth zone in a Type I, nominally boron-free diamond (NL247-23) gave repeated zero counts in the 100 s counting interval, and another with 0.01 cps, which is equivalent to a background contribution of < 0.2 ng/g B. The measurements were quantified using the boron concentration of sample NL247-20 as a primary standard, which was determined by hyperspectral cathodoluminescence (0.185 ppm ± 0.008 [2σ s.d.]; Figure 2). NL247-20 was chosen because of its extremely homogeneous nitrogen and boron abundances as determined by ion probe analyses and CL imaging. The hyperspectral CL measurements utilized a FEI Quanta 250 field emission gun SEM with a Gatan cryo-stage at the University of Calgary. We calculated the boron concentration by monitoring the maximum peak intensity of bound (BE) and free excitons (FE) at a 2400 l/mm diffraction grating (Barjon *et al.*, 2011). The BE/FE ratio remained consistent over a range of accelerating voltage (15–20 kV), beam current (15–25 nA), and spectral resolution (approx. 0.26–0.19 nm) but differed substantially with temperature (88–102 K). Thus, we analyzed NL247-20 using similar parameters to the calibration developed by Barjon *et al.* (2011), including a 200 μm slit width for ~0.26 nm spectral resolution at 102 K.

Carbon isotope data, along with nitrogen and boron content are reported in Table 2 and Data S3.

3. Trace element content of blue diamonds

Closed-cell ablations of the natural blue diamonds for trace elemental analyses were carried out following the methods outlined by McNeill *et al.* (2009), modified for the University of Alberta ablation system (Krebs *et al.*, 2019). The ablations for samples analyzed here yielded 0.5–4.3 mg of diamond at low fluences (~4 J/cm^2 measured at the site of ablation). Where possible, we analyzed diamonds that were previously analyzed for boron isotopes. Following ablation, 5–6 mL of 6 M HCl was added to the cell prior to ultrasonication for 35 minutes with a Teflon lid. The solution was then transferred to a Teflon vial for drying down at 100 °C. The dried solution was then taken up in 1 mL of 0.8M HNO_3 solution (with 2 ppb In and Ir as internal standards) for 30 hr at 120 °C. Four total procedural blanks (TPBs) were analyzed to determine the blank contribution. The TPB and samples were analyzed on a Thermo Scientific Element XR ICPMS. To increase sensitivity an APEX-Q high-efficiency sample introduction system was used. A 3-minute wash was run between every sample. Concentrations were calibrated using 5-point weighted regression lines derived from 25,000×, 50,000×, 100,000×, 250,000×, and 500,000× dilutions of a synthetic rock multi-element standard solution. All samples were corrected for instrument drift. We fully propagate uncertainty, including that of the calibrated line and use a 7σ limit of quantification (LOQ) based on the TPB. Trace element data are reported in Data S2 and Table 1).

Given the extremely low concentrations of REE in these diamonds (~50 pg/g to ~5 ng/g La), a leaching experiment was completed following these analyses to determine the La and Ce blank produced from the silica glass ablation window that was polished in a Ce-La slurry. Three distinct experiments with concentrated 90 % HNO_3:10 % HF were completed: 1) The polished faces of two windows were rinsed with 2 mL, 2) 300 μL was placed on the polished faces of four windows for 10–20 minutes, 3) three windows were fully submerged in 5 mL of the solution for 10–20 minutes. These digestions allowed for the sampling of contamination sourced from the polished face of the window, as well as from the rough, unpolished sides of the window. Following collection, the solution was dried down at 100 °C and taken up in 1 mL dilute nitric acid with a 2000 ppt Ir internal standard for 30 hours at 120 °C. Subsequent analyses of trace elements were completed on a Thermo Scientific Element XR with the same procedure as above.

Except for cerium, which has a median concentration of 0.48 ng/g, nearly all trace elements were below the limit of quantification for the six experiments that sampled the polished face of windows by a 10–20 min. soak or rinse (data S6). The windows that were fully submerged in the solution show measurable LREE concentrations, with an extensively scratched and damaged window having the highest elemental concentrations (sample 20-6). The contamination of these window by LREE is likely due to the initial polishing of the window by a La-Ce slurry. Despite extensive acid cleaning prior to ablation, this contamination appears to persist, especially in the unpolished regions of the window. While no acid touches the window during the procedure for trace elemental analyses of blue diamonds, we postulate that contamination of the sample from the window may occur during the energetic fragmentation of the diamond during ablation. In fact, the average Ce/La ratio of the unpolished face dissolutions (Ce/La = 3.7) closely matches the Ce/La ratio of 5 of our blue diamond analyses (Ce/La = 3.0–4.7). Following the results of this study, we have excluded Ce and La measurements that appear to show this contaminant signal (Ce/La $\sim$ 3), and suggest that positive Ce anomalies reported in other diamond analyses (Krebs *et al.*, 2019; Timmerman *et al.*, 2019d) are treated with caution.

4. Boron isotopes – standards and samples

Laser ablations for boron isotopic analyses ($^{11}B/^{10}B$, expressed relative to NIST SRM951 as $\delta^{11}B_{SRM951}$) were conducted using an offline, 193 nm ArF Excimer laser system at the University of Alberta with the ablation product being collected in a custom-made Teflon ablation cell that was capped with a silica glass window (McNeill *et al.*, 2009). All sample handling and cleaning took place in ULPA-filtered class 10 laminar flow hoods. Prior to the ablations, the ablation cells and sample vials were cleaned in 6M HCl and concentrated HNO_3 for more than 48 hours, and the silica glass windows were cleaned in 5 % HF for 3 minutes and 6M HCl and 8M HNO_3 for more than 48 hours.

In order to assess the accuracy of the analytical method, two 1 cm pressed pellet biogenic reference materials, previously determined for their boron isotopic composition (Farmer *et al.*, 2016; Gutjahr *et al.*, 2020) were ablated. The resulting ablation products, corresponding to 1.5–9.7 mg $CaCO_3$, were collected in ~1 mL of 18.2 MΩ·cm H_2O. Boron was separated from this solution following the methods previously outlined (Foster, 2008; Foster *et al.*, 2013). Briefly, this solution was loaded in a 2M sodium acetate-0.5 M acetic acid buffer, collected using an anionic exchange resin (Amberlite IRA 743; Kiss, 1988), and eluted in 0.5M HNO_3, which was necessary to remove the Ca-rich matrix and hence reduce space charge matrix effects in the plasma (Foster, 2008; Foster *et al.*, 2013). Replicate ablations were also completed on synthetic, B-doped diamonds to determine the analytical precision of the method. The diamonds were cleaned in acid prior to ablation (concentrated HF, HCl, HNO_3). The ablated material, corresponding to 1.1–2.6 mg diamond, was collected in 0.5 mL dilute nitric acid. Column chemistry for the diamond samples was not necessary, given that the matrix carbon dissipates as CO_2 in the ambient atmosphere of the closed ablation cell.

Subsequent solution-based analysis of boron was completed on a Thermo Neptune MC-ICP-MS with a PFA spray chamber at the University of Southampton (National Oceanographic Centre Southampton) using well-established methods (Foster, 2008; Foster *et al.*, 2013). Two Faraday cup detectors were equipped with 10^{12} Ω resistors on the amplifier circuits. The sample gas was tuned daily to optimize ratio stability on NIST SRM 951, which generally resulted in a small loss of signal intensity (~0.6 V per 50 ppb B at ~60 μL/min uptake rate), and ammonia gas was added to ensure an efficient B signal wash-out time and to reduce memory effects (Foster, 2008). Instrumental mass bias was corrected using rapidly bracketed 35 to 50 ppb NIST SRM 951 boric acid standard (Foster, 2008). Secondary standards of low concentration ERM-AE120 and a 5 ppb solution of NIST SRM 951 were used as internal consistency standards to check for ratio drift and accuracy of low concentration analyses. Standard-bracketed sample measurements were corrected by repetitive measurements on the sample acid blank. The take-up rate was approximately ~60 μL/min.

The measurements of the ablated biogenic carbonate standards (JCp-1 and JCt-1) reproduced the known $\delta^{11}B$ within 2 ‰ (Farmer *et al.*, 2016; Gutjahr *et al.*, 2020) (data S4), suggesting that this method is accurate for B isotopic analyses at this level of precision. The analyses for synthetic diamond were also surprisingly reproducible given the large variation in laser fluence (4–7 J/cm^2), ablated material weight, dissolved B concentration, and solution volume. Six repeat attempts over four different ablation sessions characterized two doubly polished wafers of a synthetic, B-doped diamond (0.2 to 18 μg/g B) and produced a δ^{11}B of 2.5 ± 0.8 ‰ 2σ standard deviation (data S4). The precision of these synthetic diamond δ^{11}B analyses, along with the accurate δ^{11}B of the biogenic carbonate standards, suggest that our procedure produces δ^{11}B measurements of natural diamonds within <2 ‰, which is deemed sufficient for the purposes of this study.

Ablations of natural blue diamonds were completed in the same sessions as ablations on synthetic blue diamonds and utilized identical analytical procedures. Early ablations that utilized higher fluences (5–7 J/cm^2 measured at the site of ablation) resulted in heavy diamond fragmentation, graphitization, and viscous solutions that may have indicated contamination of the solution with melted Teflon due to the conductive nature of the diamonds. Lower fluences (~4 J/cm^2) were favored during later ablations (September 2019 and February 2020) as they yielded much less graphitization, less heat, and resulted in non-viscous solutions. The ablations of the natural diamonds corresponded to 1.5–8.5 mg diamond and yielded solutions with an average B concentration of 3.8 ppb (1.1 ng) B, with a range from 2.3–5.9 ppb (0.5–1.8 ng) B solutions (Figure **??**). These concentrations approximated, within 80 %, the calculated total B yield, which utilized the *in situ* ionprobe determined B concentrations and the weights of the diamonds before and after ablation. Two total procedural blanks (TPB) were determined for each batch of samples processed ($n = 6$). These were prepared by placing a diamond into an ablation cell, capping the cell with a silica glass window, and utilizing the same reagents as those for the sample, even though no ablation took place. Boron concentrations of the TPB solutions averaged 0.6 ppb (0.2 ng) and ranged from 0.3 ppb to 0.9 ppb (0.09–0.3 ng). TPB $\geqslant$ 0.8 ppb were analyzed for their δ^{11}B for subsequent blank subtraction. 2σ errors associated with blank subtraction, bracketing standard variability (Figure 1), and reproducibility of the synthetic diamond were propagated into the final analyses reported for the natural diamonds and ranged from 1.3 to 2.2 ‰ at 95 % confidence. We exclude one analysis of a blue diamond solution (AB-2) that was analyzed in November of 2018 because it was relatively viscous and produced an extreme jump in bracketing standards of > 2 ‰, indicative of a bias induced by contamination of the sample with organics from the melted Teflon cell. Due to lower ablation fluences, none of the solutions analyzed later (September 2019 and February 2020) suffered from this problem.

Boron isotopic data are reported in Table 1 in the main text, and in Data S4.

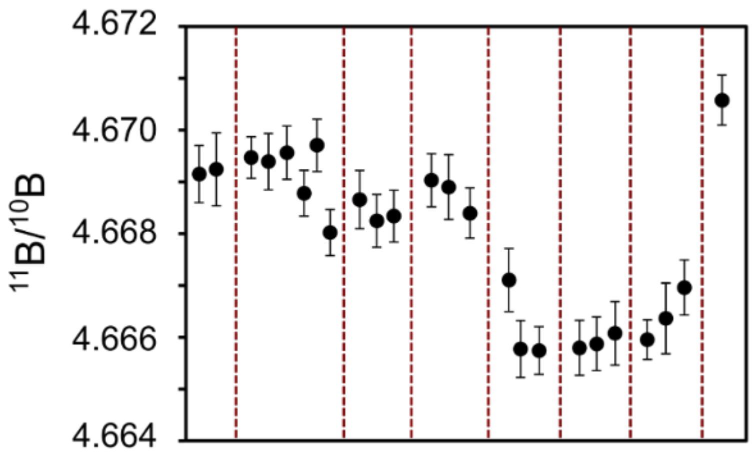

Figure 1: $^{11}B/^{10}B$ measurements for a 50 ppb SRM 951 standard over a full day of analyses. Dotted red lines indicate sample measurements. Error bars show internal uncertainty at 2σ. Sample bracketing standard jumps are generally no greater than those between repeat analyses of SRM 951. The largest sample bracketing standard jump shown here is the last sample (0.75 ‰, far right). The errors associated with these uncertainties are propagated into the total sample error.

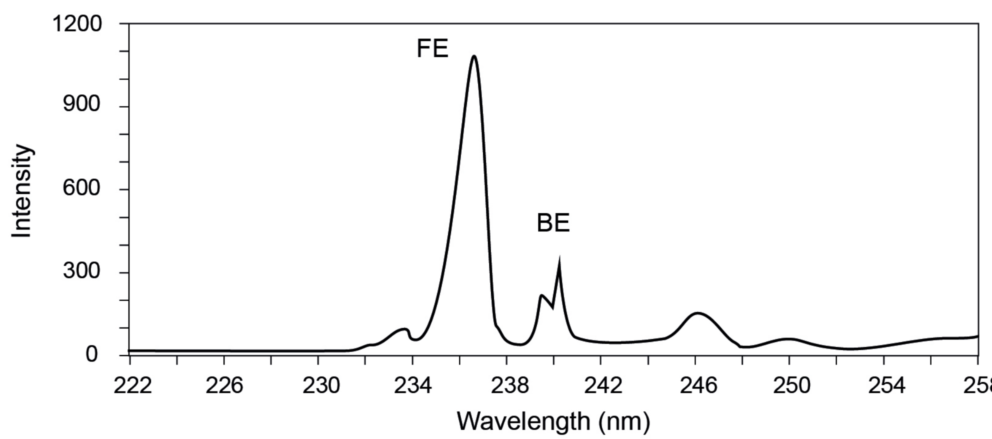

Figure 2: Cathodoluminescence (CL) spectrum from NL247-20. The ratio between the neutral-boron bound exciton (BE) and the free-exciton (FE) intensities is proportional to boron concentration (Barjon *et al.*, 2011). This sample was used to calibrate the ionprobe analyses of boron concentration.

Table 1: Trace element abundances (ppb) in blue diamonds.

	NL247-2	err	NL247-5	err	NL247-6	err	NL247-12	err	NL247-13	err	NL247-14	err	Blue1	err	Blue2	err	AB	err
Cs	<LOD	<LOD	9.03	0.50	1.65	0.06	0.72	0.08	2.25	0.11	3.27	0.17	1.32	0.09	0.71	0.09	0.02	0.01
Rb	<LOD	<LOD	8.70	2.95	0.33	0.42	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.26	0.60	1.18	1.39	1.39	0.43
Pb	0.26	0.37	2.03	0.45	0.47	0.07	0.70	0.10	0.26	0.10	1.29	0.21	1.59	0.13	1.45	0.23	0.95	0.12
Ba	2.32	3.49	34.44	1.78	3.17	0.21	7.11	0.52	1.90	0.06	16.34	0.70	2.85	0.18	7.53	0.61	13.36	0.65
Th	0.00	0.04	0.83	0.18	0.01	0.04	0.01	0.03	0.08	0.04	0.13	0.06	0.02	0.03	0.13	0.06	0.01	0.02
U	0.02	0.03	0.10	0.04	0.04	0.01	0.09	0.29	0.03	0.01	0.09	0.02	0.04	0.03	0.03	0.02	0.03	0.01
Nb	<LOD	<LOD	0.25	0.51	0.15	0.08	0.13	0.10	0.44	0.21	0.14	0.25	0.80	0.11	0.04	0.24	0.78	0.19
K	<LOD	<LOD	5682	7913	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	728	3658	<LOD	<LOD	517	3787	4267	1010
La	0.062	0.315	4.889	0.761	0.054	0.104	<LOD	<LOD	0.117	0.167	0.425	0.331	1.201	0.185	0.371	0.340	0.087	0.089
Ce	<LOD	<LOD	31.763	2.383	0.280	0.245	0.042	0.333	0.294	0.388	0.349	0.789	14.617	0.794	2.126	0.818	0.105	0.208
Pr	0.010	0.024	0.303	0.056	0.007	0.003	0.008	0.004	0.054	0.020	0.341	0.034	0.027	0.009	0.035	0.020	0.011	0.003
Sr	0.179	4.920	2.654	17.154	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	38.735	8.211	<LOD	<LOD	<LOD	<LOD	0.106	2.109
Nd	0.034	0.064	1.439	0.500	0.030	0.024	0.022	0.024	0.303	0.067	1.704	0.349	0.154	0.033	0.143	0.145	0.042	0.018
Sm	0.011	0.019	0.222	0.151	0.006*	0.010*	0.009*	0.009	0.109	0.051	0.093	0.123	0.014	0.028	0.039	0.042	0.006*	0.003*
Hf	<LOD	<LOD	1.311	0.614	0.184	0.067	0.049	0.075	0.091	0.092	0.113	0.186	0.254	0.087	0.121	0.198	0.094	0.049
Eu	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Tb	0.001	0.003	0.045	0.016	0.001	0.003	<LOD	<LOD	0.016	0.005	0.007	0.005	0.003	0.003	0.002	0.002	0.011	0.003
Dy	0.008	0.009	0.249	0.130	<LOD	<LOD	0.005	0.005	0.105	0.027	0.135	0.065	0.013	0.011	0.018*	0.011*	0.014	0.006
Ho	0.002	0.004	0.055	0.033	0.001	0.001	0.001	0.003	0.030	0.008	0.009	0.007	0.003	0.003	0.006	0.008	0.004	0.003
Er	<LOD	<LOD	0.121	0.068	0.004	0.004	0.007	0.007	0.085	0.030	0.024*	0.024*	0.011*	0.008*	¡LOD	¡LOD	0.012*	0.012*
Yb	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Lu	0.001*	0.002*	0.021	0.026	<LOD	<LOD	<LOD	<LOD	0.013	0.006	<LOD	<LOD	<LOD	<LOD	0.003*	0.003*	0.008	0.003
Zr	0.76	3.41	52.37	10.25	5.76	2.05	0.00*	0.00*	2.66	2.22	5.05	4.60	7.15	2.04	4.07	4.64	3.22	1.27
V	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Sc	<LOD	<LOD	<LOD	<LOD	36.74	1.49	17.98	1.26	<LOD	<LOD	<LOD	<LOD	9.24	1.33	<LOD	<LOD	<LOD	<LOD
Zn	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	4945	1995	<LOD	<LOD	6811	2224	108337	19488
Cu	17.24	21.81	129.14	27.50	44.02	9.41	<LOD	<LOD	18.66	4.19	76.50	14.93	1239.59	226.80	30.08	7.61	262.95	48.24
Ti	<LOD	<LOD	431	43	145	82	<LOD	<LOD	1188	222	161	195	3199	250	164	43	66	35
Mn	0.62	2.18	22.50	3.89	0.72	0.54	<LOD	<LOD	1.06	0.85	8.79	1.76	7.25	0.97	8.72	2.17	1.43	0.47
Fe	20.9	73.4	563.6	219.3	49.1	31.6	<LOD	<LOD	311.4	51.8	414.3	103.6	176.7	45.5	791.5	116.6	201.4	28.8
Co	<LOD	<LOD	3.68	0.90	0.08*	0.09*	<LOD	<LOD	1.75	0.30	3.13	0.59	2.32	0.23	4.81	0.49	57.58	3.00
Mg	<LOD	<LOD	9252.50*	458.35*	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Ni	2.60	1.13	22.66	1.27	3.47	0.36	<LOD	<LOD	66.63	3.04	15.15	1.28	6.74	0.45	33.19	2.03	11.19	0.85
Cr	0.07*	3.64*	101.17	14.40	6.78	1.96	<LOD	<LOD	4.70	2.99	95.26	7.63	9.15	4.76	8.08	6.28	150.60	7.03

<LOD indicates below limit of detection (blank + 3σ), * indicates below limit of quantification (blank + 7σ).

Table 2: Carbon isotopes, nitrogen concentration, and boron concentration of blue diamonds.

Diamond	Spot Name	δ^{13}C (‰)	2σ (‰)	N (ppm)	2σ (ppm)	B (ppm)	2σ (ppm)
NL247-2	S5649-1	−15.50	0.15	<0.35		0.014	0.003
NL247-2	S5649-2	−15.58	0.13	<0.35		0.015	0.003
NL247-2	S5649-3	−15.74	0.14	<0.35		0.253	0.013
NL247-2	S5649-4	−15.60	0.13	<0.35		0.013	0.003
NL247-2	S5649-5	−15.65	0.14	<0.35		0.013	0.003
NL247-2	S5649-6	−15.56	0.15	<0.35		0.018	0.005
NL247-2	S5649-7	−15.58	0.15	<0.35		0.019	0.003
NL247-2	S5649-8	−15.54	0.14	<0.35		0.015	0.003
NL247-2	S5649-9	−15.66	0.16	<0.35		0.246	0.012
NL247-2	S5649-10	−15.73	0.15			0.251	0.013
NL247-2	S5649-11	−15.61	0.13	<0.35			
NL247-2	S5649-12	−15.60	0.14			0.243	0.012
NL247-2	S5649-13			<0.35			
NL247-2	S5649-14	−15.71	0.16			0.236	0.012
NL247-2	S5649-15			<0.35			
average		−15.62	0.16	<0.35		0.111	0.007
2σ		0.15				0.238	
NL247-3	S5650-1	−16.77	0.13	<0.35		0.159	0.011
NL247-3	S5650-2	−16.90	0.15			0.199	0.011
NL247-3	S5650-3	−16.90	0.15	<0.35		0.228	0.014
NL247-3	S5650-4						
NL247-3	S5650-5			<0.35			
NL247-3	S5650-6	−16.98	0.13			0.150	0.009
NL247-3	S5650-7			<0.35			
NL247-3	S5650-8	−16.90	0.17			0.182	0.012
NL247-3	S5650-9	−16.96	0.14	<0.35		0.188	0.013
NL247-3	S5650-10						
NL247-3	S5650-11	−16.88	0.13	<0.35		0.118	0.008
NL247-3	S5650-12						
average		−16.90	0.17	<0.35		0.175	0.011
2σ		0.14				0.072	
NL247-4	S5651-1	−16.85	0.13	<0.5		0.211	0.013
NL247-4	S5651-2	−16.94	0.13	<0.5		0.191	0.011
NL247-4	S5651-3	−16.77	0.14	<0.5		0.156	0.010
NL247-4	S5651-4	−16.86	0.12	<0.5		0.197	0.015
NL247-4	S5651-5	−16.83	0.13	<0.5		0.210	0.011
NL247-4	S5651-6	−16.84	0.15	<0.5		0.156	0.010
NL247-4	S5651-7	−16.85	0.13	<0.5		0.173	0.014
NL247-4	S5651-8	−16.82	0.13	<0.5		0.190	0.013
NL247-4	S5651-9	−16.85	0.14	<0.5		0.228	0.017
NL247-4	S5651-10	−16.78	0.12	<0.5		0.204	0.013
NL247-4	S5651-11	−16.80	0.13	<0.5		0.208	0.011
NL247-4	S5651-12	−16.77	0.12	<0.5		0.204	0.011
NL247-4	S5651-13	−16.81	0.14	<0.5		0.172	0.012
NL247-4	S5651-14	−16.90	0.13	<0.5		0.195	0.011
average		−16.83	0.15	<0.5		0.193	0.012

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Table 2 – continued

Diamond	Spot Name	$\delta^{13}C$ (‰)	2σ (‰)	N (ppm)	2σ (ppm)	B (ppm)	2σ (ppm)
2σ		0.09				0.042	
NL247-5	S5652-1	−16.75	0.14	<0.5		0.019	0.004
NL247-5	S5652-2	−16.79	0.14	<0.5		0.014	0.004
NL247-5	S5652-3	−16.75	0.12	<0.5		0.015	0.003
NL247-5	S5652-4	−-16.82	0.12	<0.5		0.017	0.003
NL247-5	S5652-5	−16.81	0.15	<0.5		0.013	0.004
NL247-5	S5652-6	−16.72	0.17	<0.5		0.015	0.003
NL247-5	S5652-7	−16.66	0.13	<0.5		0.015	0.003
NL247-5	S5652-8	−16.74	0.13	<0.5		0.013	0.003
NL247-5	S5652-9	−16.82	0.12	<0.5		0.199	0.011
NL247-5	S5652-10	−16.78	0.16	<0.5		0.013	0.003
NL247-5	S5652-11	−16.65	0.12	<0.5		0.017	0.003
NL247-5	S5652-12	−16.72	0.15	<0.5		0.015	0.003
NL247-5	S5652-13	−16.87	0.14	<0.5		0.240	0.013
NL247-5	S5652-14	−16.69	0.17	<0.5		0.013	0.003
NL247-5	S5652-15	−16.83	0.13	<0.5		0.208	0.015
average		−16.76	0.17	<0.5		0.055	0.005
2σ		0.13				0.167	
NL247-6	S5653-1	−16.58	0.13	<0.5		0.015	0.004
NL247-6	S5653-2	−16.72	0.13	<0.5		0.015	0.003
NL247-6	S5653-3	−16.62	0.15	<0.5		0.013	0.004
NL247-6	S5653-4	−16.64	0.15	<0.5		0.016	0.003
NL247-6	S5653-5	−16.66	0.16	<0.5		0.016	0.003
NL247-6	S5653-6	−16.72	0.15	<0.5		0.032	0.005
NL247-6	S5653-7	−16.76	0.14	<0.5		0.033	0.006
NL247-6	S5653-8	−16.69	0.18	<0.5		0.036	0.005
NL247-6	S5653-9	−16.55	0.15	<0.5		0.011	0.003
NL247-6	S5653-10	−16.72	0.13	<0.5		0.203	0.013
NL247-6	S5653-11	−16.74	0.16	<0.5		0.030	0.005
NL247-6	S5653-12	−16.69	0.18	<0.5		0.015	0.003
NL247-6	S5653-13	−16.74	0.15	<0.5		0.030	0.005
average		−16.68	0.18	<0.5		0.045	0.005
2σ		0.13				0.102	
NL247-7	S5654-1	−16.47	0.14	<0.5		0.226	0.012
NL247-7	S5654-2	−16.37	0.14	<0.5		0.204	0.012
NL247-7	S5654-3	−16.54	0.14	<0.5		0.235	0.013
NL247-7	S5654-4	−16.50	0.16	<0.5		0.208	0.012
NL247-7	S5654-5	−16.49	0.14	<0.5		0.186	0.012
NL247-7	S5654-6	−16.36	0.14	<0.5		0.234	0.013
NL247-7	S5654-7	−16.47	0.13	<0.5		0.203	0.012
NL247-7	S5654-8	−16.52	0.14	<0.5		0.151	0.013
NL247-7	S5654-9	−16.45	0.14	<0.5		0.222	0.013
NL247-7	S5654-10	−16.52	0.13	<0.5		0.195	0.012
NL247-7	S5654-11	−16.52	0.14	<0.5		0.197	0.012
NL247-7	S5654-12	−16.47	0.13	<0.5		0.190	0.013
NL247-7	S5654-13	−16.63	0.15	<0.5		0.165	0.010
NL247-7	S5654-14	−16.48	0.13	<0.5		0.213	0.012

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Table 2 – continued

Diamond	Spot Name	$\delta^{13}C$ (‰)	2σ (‰)	N (ppm)	2σ (ppm)	B (ppm)	2σ (ppm)
average		−16.49	0.16	<0.5		0.202	0.012
2σ		0.13				0.049	
NL247-8	S5655-1	−16.92	0.13	<0.35		0.150	0.009
NL247-8	S5655-2	−16.86	0.15			0.198	0.010
NL247-8	S5655-3	−16.83	0.16	<0.35		0.172	0.012
NL247-8	S5655-4	−16.88	0.15			0.182	0.010
NL247-8	S5655-5	−16.94	0.13	<0.35		0.214	0.011
NL247-8	S5655-6	−16.79	0.15			0.197	0.013
NL247-8	S5655-7	−16.85	0.14	<0.35		0.214	0.014
NL247-8	S5655-8	−16.87	0.13			0.185	0.011
NL247-8	S5655-9			<0.35		0.243	0.011
NL247-8	S5655-10						
NL247-8	S5655-11			<0.35			
NL247-8	S5655-12						
NL247-8	S5655-13			<0.35			
NL247-8	S5655-14						
NL247-8	S5655-15			<0.35			
average		−16.87	0.16	<0.35		0.195	0.011
2σ		0.10				0.054	
NL247-9	S5656-1	−15.04	0.14	<0.5		0.011	0.003
NL247-9	S5656-2	−15.14	0.15	<0.5		0.091	0.008
NL247-9	S5656-3	−14.47	0.13	<0.5		0.008	0.002
NL247-9	S5656-4	−14.52	0.16	<0.5		0.113	0.010
NL247-9	S5656-5	−14.63	0.13	<0.5		0.093	0.008
NL247-9	S5656-6	−14.45	0.13	<0.5		0.104	0.010
NL247-9	S5656-7	−14.65	0.13	<0.5		0.113	0.009
NL247-9	S5656-8	−14.52	0.14	<0.5		0.114	0.009
NL247-9	S5656-9	−14.42	0.14	<0.5		0.008	0.003
NL247-9	S5656-10	−14.51	0.13	<0.5		0.096	0.008
NL247-9	S5656-11	−14.55	0.13	<0.5		0.107	0.011
NL247-9	S5656-12	−14.67	0.14	<0.5		0.099	0.008
NL247-9	S5656-13	−14.51	0.13	<0.5		0.116	0.009
NL247-9	S5656-14	−14.54	0.14	<0.5		0.103	0.009
NL247-9	S5656-15	−14.60	0.13	<0.5		0.103	0.008
NL247-9	S5656-16	−14.41	0.13	<0.5		0.006	0.002
NL247-9	S5656-17	−15.00	0.13	<0.5		0.010	0.004
average		−14.63	0.16	<0.5		0.076	0.007
2σ		0.44				0.091	
NL247-10	S5657A-1	−16.49	0.14	<0.5		0.014	0.003
NL247-10	S5657A-2	−16.53	0.13	<0.5		0.016	0.004
NL247-10	S5657A-3	−16.53	0.14	<0.5		0.199	0.012
NL247-10	S5657A-4	−16.60	0.15	<0.5		0.160	0.010
NL247-10	S5657A-5	−16.65	0.14	<0.5		0.197	0.012
NL247-10	S5657A-6	−16.47	0.13	<0.5		0.142	0.013
NL247-10	S5657A-7	−16.49	0.15	<0.5		0.191	0.011
NL247-10	S5657A-8	−16.69	0.14	<0.5		0.207	0.012
NL247-10	S5657A-9	−16.61	0.14	<0.5		0.177	0.012

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Table 2 – continued

Diamond	Spot Name	$\delta^{13}C$ (‰)	2σ (‰)	N (ppm)	2σ (ppm)	B (ppm)	2σ (ppm)
NL247-10	S5657A-10	−16.53	0.14	<0.5		0.179	0.011
NL247-10	S5657A-11	−16.47	0.14	<0.5		0.136	0.013
NL247-10	S5657A-12	−16.49	0.15	<0.5		0.123	0.009
NL247-10	S5657A-13	−16.67	0.14	<0.5		0.204	0.015
average		−16.55	0.15	<0.5		0.149	0.011
2σ		0.16				0.131	
NL247-11	S5659-1	−15.65	0.14	<0.5		0.013	0.003
NL247-11	S5659-2	−15.63	0.14	<0.5		0.025	0.004
NL247-11	S5659-3	−15.82	0.14	<0.5		0.148	0.014
NL247-11	S5659-4	−15.74	0.15	<0.5		0.168	0.011
NL247-11	S5659-5	−15.73	0.13	<0.5		0.175	0.012
NL247-11	S5659-6	−15.67	0.13	<0.5		0.165	0.015
NL247-11	S5659-7	−15.64	0.14	<0.5		0.130	0.011
NL247-11	S5659-8	−15.67	0.13	<0.5		0.177	0.011
NL247-11	S5659-9	−15.75	0.13	<0.5		0.173	0.011
NL247-11	S5659-10	−15.81	0.14	<0.5		0.169	0.014
NL247-11	S5659-11	−15.78	0.14	<0.5		0.172	0.014
NL247-11	S5659-12	−15.74	0.14	<0.5		0.154	0.014
NL247-11	S5659-13	−15.82	0.14	<0.5		0.172	0.011
average		−15.73	0.15	<0.5		0.142	0.011
2σ		0.14				0.112	
NL247-12	S5660-1	−15.29	0.15	<0.3			
NL247-12	S5660-2	−15.23	0.14				
NL247-12	S5660-3	−15.34	0.15	<0.35			
NL247-12	S5660-4	−15.33	0.12	<0.35			
NL247-12	S5660-5	−15.31	0.12	<0.35			
NL247-12	S5660-6	−15.42	0.15				
NL247-12	S5660-7	−15.33	0.14	<0.35			
NL247-12	S5660-8	−15.44	0.15				
NL247-12	S5660-9	−15.32	0.14	<0.35			
NL247-12	S5660-10	−15.41	0.12				
NL247-12	S5660-11	−15.38	0.13				
NL247-12	S5660-12	−15.34	0.13				
NL247-12	S5660-13	−15.39	0.14				
NL247-12	S5660-14	−15.36	0.12				
NL247-12	S5660-15	−15.34	0.12				
NL247-12	S5660-16	−15.24	0.13				
average		−15.34	0.15	<0.35			
2σ		0.12					
NL247-13	S5661-1	−16.70	0.14	<0.5		0.003	0.001
NL247-13	S5661-2	−16.76	0.14	<0.5		0.276	0.014
NL247-13	S5661-3	−16.85	0.15	<0.5		0.287	0.016
NL247-13	S5661-4	−16.75	0.13	<0.5		0.251	0.014
NL247-13	S5661-5	−16.85	0.15	<0.5		0.266	0.017
NL247-13	S5661-6	−16.72	0.13	<0.5		0.259	0.019
NL247-13	S5661-7	−16.77	0.15	<0.5		0.255	0.014
NL247-13	S5661-8	−16.87	0.13	<0.5		0.263	0.015

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Table 2 – continued

Diamond	Spot Name	$\delta^{13}C$ (‰)	2σ (‰)	N (ppm)	2σ (ppm)	B (ppm)	2σ (ppm)
NL247-13	S5661-9	−16.84	0.14	<0.5		0.260	0.018
NL247-13	S5661-10	−16.93	0.16	<0.5		0.253	0.017
NL247-13	S5661-11	−16.88	0.15	<0.5		0.265	0.014
NL247-13	S5661-12	−16.76	0.16	<0.5		0.241	0.013
NL247-13	S5661-13	−16.74	0.14	<0.5		0.248	0.014
NL247-13	S5661-14			<0.5			
average		−16.80	0.16	<0.5		0.241	0.014
2σ		0.14				0.145	
NL247-14	S5662-1	−15.84	0.16			0.015	0.003
NL247-14	S5662-2	−15.77	0.15			0.031	0.004
NL247-14	S5662-3	−15.69	0.13			0.020	0.003
NL247-14	S5662-4	−15.78	0.13			0.027	0.005
NL247-14	S5662-5	−15.80	0.13			0.026	0.004
NL247-14	S5662-6	−15.94	0.15			0.239	0.013
NL247-14	S5662-7						
NL247-14	S5662-8						
NL247-14	S5662-9	−16.04	0.15			0.272	0.012
NL247-14	S5662-10						
NL247-14	S5662-11	−15.74	0.13			0.024	0.004
NL247-14	S5662-12	−15.90	0.14			0.275	0.012
NL247-14	S5662-13						
NL247-14	S5662-14	−16.00	0.14			0.268	0.014
average		−15.85	0.16			0.120	0.007
2σ		0.23				0.248	
NL247-15	S5663-1	−16.48	0.13	<0.5		0.199	0.012
NL247-15	S5663-2	−16.28	0.14	<0.5		0.184	0.017
NL247-15	S5663-3	−16.49	0.13	<0.5		0.132	0.010
NL247-15	S5663-4	−16.57	0.14	<0.5		0.180	0.013
NL247-15	S5663-5			<0.5		0.230	0.013
NL247-15	S5663-6	−16.60	0.14	<0.5		0.166	0.012
NL247-15	S5663-7	−16.74	0.15	<0.5		0.211	0.013
NL247-15	S5663-8	−16.71	0.13	<0.5		0.182	0.013
NL247-15	S5663-9	−16.75	0.13	<0.5		0.124	0.010
NL247-15	S5663-10	−16.56	0.13	<0.5		0.012	0.003
NL247-15	S5663-11	−16.65	0.15	<0.5		0.017	0.004
NL247-15	S5663-12	−16.61	0.13	<0.5		0.017	0.004
NL247-15	S5663-13	−16.58	0.14	<0.5		0.016	0.004
NL247-15	S5663-14	−16.75	0.13	<0.5		0.200	0.016
average		−16.60	0.15	<0.5		0.134	0.010
2σ		0.27				0.165	
NL247-16	S5664-1	−16.64	0.15			0.021	0.004
NL247-16	S5664-2						
NL247-16	S5664-3						
NL247-16	S5664-4						
NL247-16	S5664-5						
NL247-16	S5664-6	−16.87	0.14			0.024	0.004
NL247-16	S5664-7	−16.79	0.14			0.028	0.006

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Table 2 – continued

Diamond	Spot Name	$\delta^{13}C$ (‰)	2σ (‰)	N (ppm)	2σ (ppm)	B (ppm)	2σ (ppm)
NL247-16	S5664-8	−16.77	0.16			0.017	0.003
NL247-16	S5664-9	−16.73	0.17			0.045	0.005
NL247-16	S5664-10	−16.90	0.14			0.259	0.013
NL247-16	S5664-11	−16.72	0.14			0.271	0.012
NL247-16	S5664-12						
NL247-16	S5664-13						
NL247-16	S5664-14	−16.94	0.13			0.269	0.012
NL247-16	S5664-15	−16.96	0.14			0.293	0.018
NL247-16	S5664-16						
average		−16.81	0.17			0.136	0.008
2σ		0.22				0.260	
NL247-17	S5665-1	−16.83	0.14	<0.35		0.126	0.009
NL247-17	S5665-2	−16.81	0.13			0.169	0.009
NL247-17	S5665-3	−16.81	0.15	<0.35		0.214	0.011
NL247-17	S5665-4	−16.83	0.13	<0.35		0.014	0.003
NL247-17	S5665-5	−16.74	0.15	<0.35		0.012	0.003
NL247-17	S5665-6	−16.75	0.15	<0.35		0.014	0.003
NL247-17	S5665-7	−16.91	0.13	<0.35		0.183	0.009
NL247-17	S5665-8	−16.85	0.14			0.188	0.010
NL247-17	S5665-9	−16.93	0.13	<0.35		0.223	0.011
NL247-17	S5665-10	−16.81	0.14			0.012	0.004
NL247-17	S5665-11	−16.76	0.17	<0.35		0.013	0.003
NL247-17	S5665-12	−17.07	0.13			0.034	0.004
NL247-17	S5665-13	−17.15	0.13	<0.35		0.030	0.004
average		−16.87	0.17	<0.35		0.095	0.006
2σ		0.24				0.178	0.000
NL247-18	S5666-2	−16.45	0.16				
NL247-18	S5666-3	−16.40	0.13				
NL247-18	S5666-4	−16.46	0.14				
NL247-18	S5666-5	−16.43	0.13				
NL247-18	S5666-6	−16.24	0.13				
NL247-18	S5666-7	−16.44	0.15				
NL247-18	S5666-8	−16.40	0.13				
NL247-18	S5666-9	−16.31	0.13				
NL247-18	S5666-10	−16.43	0.14				
NL247-18	S5666-11	−16.28	0.12				
average		−16.38	0.16				
2σ		0.16					
NL247-19	S5667-1	−16.50	0.14	<0.5		0.217	0.013
NL247-19	S5667-2	−16.49	0.16	<0.5		0.247	0.014
NL247-19	S5667-3	−16.47	0.13	<0.5		0.232	0.017
NL247-19	S5667-4	−16.54	0.16	<0.5		0.238	0.018
NL247-19	S5667-5	−16.40	0.13	<0.5		0.019	0.004
NL247-19	S5667-6	−16.39	0.13	<0.5		0.251	0.014
NL247-19	S5667-7	−16.43	0.14	<0.5		0.197	0.012
NL247-19	S5667-8	−16.56	0.13	<0.5		0.249	0.014
NL247-19	S5667-9	−16.47	0.16	<0.5		0.257	0.014

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Table 2 – continued

Diamond	Spot Name	$\delta^{13}C$ (‰)	2σ (‰)	N (ppm)	2σ (ppm)	B (ppm)	2σ (ppm)
NL247-19	S5667-10	−16.36	0.15	<0.5		0.015	0.004
NL247-19	S5667-11	−16.56	0.13	<0.5		0.221	0.012
NL247-19	S5667-12	−16.38	0.14	<0.5		0.237	0.013
NL247-19	S5667-13	−16.60	0.13	<0.5		0.225	0.014
average		−16.47	0.16	<0.5		0.201	0.012
2σ		0.16				0.166	
NL247-20	S5668-1	−15.70	0.13	<0.5		0.180	0.011
NL247-20	S5668-2	−15.71	0.13	<0.5		0.184	0.011
NL247-20	S5668-3	−15.53	0.15	<0.5		0.185	0.011
NL247-20	S5668-4	−15.59	0.13	<0.5		0.181	0.011
NL247-20	S5668-5	−15.61	0.14	<0.5		0.185	0.017
NL247-20	S5668-6	−15.66	0.14	<0.5		0.192	0.012
NL247-20	S5668-7	−15.77	0.15	<0.5		0.185	0.018
NL247-20	S5668-8	−15.65	0.14	<0.5		0.182	0.015
NL247-20	S5668-9	−15.63	0.15	<0.5		0.192	0.012
NL247-20	S5668-10	−15.77	0.13	<0.5		0.186	0.011
NL247-20	S5668-11	−15.67	0.15	<0.5		0.180	0.014
NL247-20	S5668-12	−15.75	0.16	<0.5		0.179	0.011
NL247-20	S5668-13	−15.70	0.13	<0.5		0.190	0.017
NL247-20	S5668-14	−15.79	0.14	<0.5		0.186	0.012
average		−15.68	0.16	<0.5		0.185	0.013
2σ		0.15				0.008	
NL247-21	S5669-1	−16.47	0.13	<0.5		0.014	0.003
NL247-21	S5669-2	−16.45	0.13	<0.5		0.014	0.003
NL247-21	S5669-3	−16.44	0.13	<0.5		0.011	0.003
NL247-21	S5669-4	−16.49	0.13	<0.5		0.208	0.012
NL247-21	S5669-5	−16.49	0.16	<0.5		0.223	0.013
NL247-21	S5669-6	−16.65	0.14	<0.5		0.254	0.014
NL247-21	S5669-7	−16.54	0.14	<0.5		0.145	0.014
NL247-21	S5669-8	−16.59	0.15	<0.5		0.212	0.013
NL247-21	S5669-9	−16.57	0.14	<0.5		0.198	0.013
NL247-21	S5669-10	−16.63	0.13	<0.5		0.234	0.014
NL247-21	S5669-11	−16.51	0.16	<0.5		0.253	0.016
NL247-21	S5669-12	−16.55	0.13	<0.5		0.236	0.013
NL247-21	S5669-13	−16.52	0.15	<0.5		0.234	0.016
NL247-21	S5669-14	−16.61	0.13	<0.5		0.237	0.013
NL247-21	S5669-15	−16.53	0.13	<0.5		0.244	0.013
average		−16.54	0.16	<0.5		0.181	0.012
2σ		0.13				0.182	
NL247-22	S5670-1	−16.34	0.13				
NL247-22	S5670-2	−16.53	0.15				
NL247-22	S5670-3	−16.52	0.14				
NL247-22	S5670-4	−16.35	0.14				
NL247-22	S5670-5	−16.55	0.16				
NL247-22	S5670-6	−16.50	0.14				
NL247-22	S5670-7	−16.37	0.13				
NL247-22	S5670-8	−16.38	0.13				

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Table 2 – continued

Diamond	Spot Name	$\delta^{13}C$ (‰)	2σ (‰)	N (ppm)	2σ (ppm)	B (ppm)	2σ (ppm)
NL247-22	S5670-9	−16.36	0.14				
NL247-22	S5670-10	−16.42	0.15				
NL247-22	S5670-11	−16.33	0.14				
NL247-22	S5670-12	−16.53	0.14				
NL247-22	S5670-13	−16.34	0.14				
NL247-22	S5670-14	−16.45	0.14				
average		−16.43	0.16				
2σ		0.17					
NL247-23	S5672-1	−4.22	0.15	313.79	10.01	0.001	0.001
NL247-23	S5672-2	−4.69	0.14	299.19	9.30		
NL247-23	S5672-3	−4.18	0.15	295.69	9.19	0.001	0.001
NL247-23	S5672-4	−5.24	0.15	727.53	22.17		0.000
NL247-23	S5672-5	−5.12	0.13	2.80	0.20	0.008	0.002
NL247-23	S5672-6	−4.12	0.14	12.85	0.59	0.001	0.001
NL247-23	S5672-7	−5.32	0.16	660.54	20.14		
average		−4.70	0.16	660.54	522.26	0.002	0.001
2σ		1.06				0.006	
Blue1	S5640B-1	−15.15	0.14	<0.35		0.126	0.010
Blue1	S5640B-2	−15.12	0.14			0.144	0.011
Blue1	S5640B-3	−15.12	0.15	<0.35		0.125	0.009
Blue1	S5640B-4	−15.08	0.15			0.120	0.009
Blue1	S5640B-5	−15.02	0.14	<0.35		0.116	0.009
Blue1	S5640B-6	−15.05	0.13			0.132	0.009
Blue1	S5640B-7	−15.08	0.14	<0.35		0.125	0.009
Blue1	S5640B-8						
Blue1	S5640B-9			<0.35			
Blue1	S5640B-10						
Blue1	S5640B-11			<0.35			
Blue1	S5640B-12						
average		−15.09	0.15	<0.35		0.127	0.009
2σ		0.09				0.018	
Blue2	S5644A-1	−18.61	0.14	<0.35			
Blue2	S5644A-2	−18.66	0.15				
Blue2	S5644A-3	−18.61	0.14	<0.35			
Blue2	S5644A-4	−18.71	0.15				
Blue2	S5644A-5	−18.53	0.14	<0.35			
Blue2	S5644A-6	−18.69	0.15				
Blue2	S5644A-7	−20.53	0.13	<0.35			
Blue2	S5644A-8	−20.84	0.14	<0.35			
Blue2	S5644A-9	−18.61	0.13				
Blue2	S5644A-10	−18.55	0.12				
Blue2	S5644A-11	−18.55	0.14	<0.35			
Blue2	S5644A-12	−18.56	0.14				
Blue2	S5644A-13	−18.63	0.13				
Blue2	S5644A-14	−18.65	0.16				
average		−18.91	0.16	<0.35			
2σ		1.51					

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Table 2 – continued

Diamond	Spot Name	$\delta^{13}C$ (‰)	2σ (‰)	N (ppm)	2σ (ppm)	B (ppm)	2σ (ppm)
AB	S5648-1	−20.73	0.15	8.56	0.83	0.498	0.027
AB	S5648-2	−20.58	0.14			0.301	0.015
AB	S5648-3	−20.63	0.14	9.18	0.44	0.315	0.020
AB	S5648-4	−20.61	0.13			0.410	0.019
AB	S5648-5			3.39	0.49		
AB	S5648-6						
AB	S5648-7			2.91	0.49		
AB	S5648-8						
AB	S5648-9	−20.42	0.16	0.76	0.10	0.306	0.016
AB	S5648-10	−20.50	0.14			0.287	0.014
AB	S5648-11	−20.56	0.16	1.41	0.25	0.262	0.013
AB	S5648-12	−20.47	0.14			0.279	0.021
AB	S5648-13			1.21	0.14		
AB	S5648-14						
AB	S5648-15			1.69	0.25		
average		−20.56	0.16	3.64	0.37	0.332	0.018
2σ		0.20		3.35		0.161	

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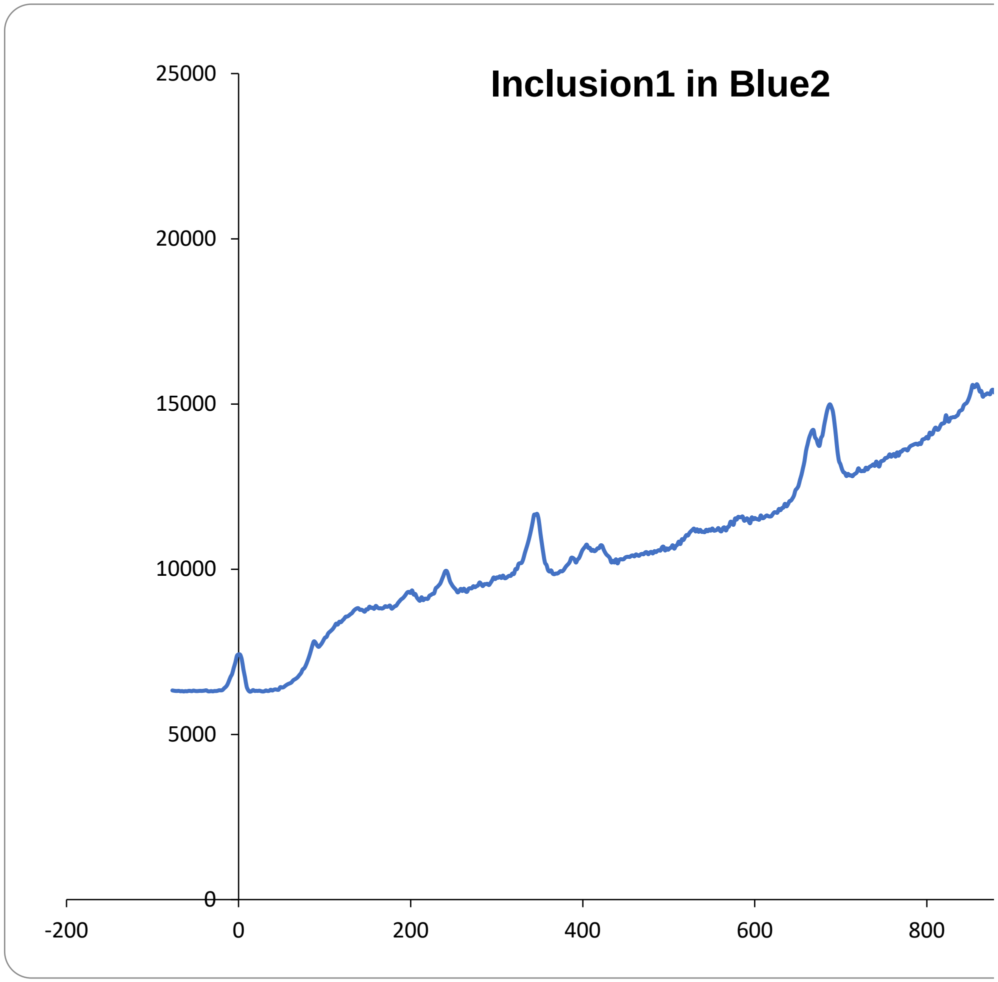
Raman spectra for inclusions in sample Blue2

Inclusion_1			Inclusion_2	
-76.945	6330		-76.945	6260
-75.062	6321		-75.062	6279
-73.179	6315		-73.179	6261
-71.295	6314		-71.295	6267
-69.412	6318		-69.412	6252
-67.53	6304		-67.53	6238
-65.649	6311		-65.649	6257
-63.767	6298		-63.767	6253
-61.886	6310		-61.886	6265
-60.006	6303		-60.006	6273
-58.125	6317		-58.125	6257
-56.245	6316		-56.245	6263
-54.365	6308		-54.365	6254
-52.486	6325		-52.486	6245
-50.607	6315		-50.607	6265
-48.728	6310		-48.728	6260
-46.85	6313		-46.85	6249
-44.971	6318		-44.971	6279
-43.094	6315		-43.094	6245
-41.216	6319		-41.216	6276
-39.34	6325		-39.34	6259
-37.464	6333		-37.464	6263
-35.587	6305		-35.587	6228
-33.711	6302		-33.711	6248
-31.836	6311		-31.836	6275
-29.961	6301		-29.961	6266
-28.086	6313		-28.086	6265
-26.211	6312		-26.211	6246
-24.338	6320		-24.338	6271
-22.463	6336		-22.463	6265
-20.591	6331		-20.591	6298
-18.717	6342		-18.717	6340
-16.844	6394		-16.844	6408



-14.972	6436	-14.972	6530
-13.1	6502	-13.1	6654
-11.229	6617	-11.229	6895
-9.3567	6738	-9.3567	7157
-7.4865	6831	-7.4865	7479
-5.6151	7015	-5.6151	7896
-3.7455	7177	-3.7455	8305
-1.8762	7381	-1.8762	8687
-0.0058	7420	-0.0058	8799
1.86284	7410	1.86284	8585
3.73116	7264	3.73116	8280
5.60062	6968	5.60062	7817
7.4683	6726	7.4683	7146
9.33566	6451	9.33566	6577
11.2027	6338	11.2027	6316
13.0709	6293	13.0709	6270
14.9373	6305	14.9373	6248
16.8034	6341	16.8034	6247
18.6691	6314	18.6691	6253
20.5346	6319	20.5346	6262
22.3997	6315	22.3997	6257
24.266	6323	24.266	6267
26.1305	6307	26.1305	6240
27.9946	6298	27.9946	6245
29.8585	6304	29.8585	6257
31.722	6329	31.722	6264
33.5852	6314	33.5852	6278
35.4481	6318	35.4481	6261
37.3107	6351	37.3107	6255
39.1715	6327	39.1715	6252
41.0334	6351	41.0334	6265
42.8951	6361	42.8951	6261
44.7564	6351	44.7564	6260
46.6173	6353	46.6173	6273
48.478	6429	48.478	6265
50.3369	6418	50.3369	6267

52.1969	6427	52.1969	6285
54.0566	6465	54.0566	6279
55.916	6499	55.916	6284
57.7737	6526	57.7737	6297
59.6324	6546	59.6324	6300
61.4909	6573	61.4909	6315
63.3475	6633	63.3475	6298
65.2054	6664	65.2054	6328
67.0628	6694	67.0628	6349
68.9186	6737	68.9186	6343
70.7754	6799	70.7754	6345
72.6305	6858	72.6305	6365
74.4867	6963	74.4867	6410
76.3412	7002	76.3412	6401
78.1968	7093	78.1968	6442
80.0506	7215	80.0506	6445
81.9041	7350	81.9041	6506
83.7588	7508	83.7588	6542
85.6116	7679	85.6116	6553
87.4657	7812	87.4657	6561
89.3179	7782	89.3179	6574
91.1698	7694	91.1698	6578
93.0215	7649	93.0215	6576
94.8742	7696	94.8742	6576
96.7252	7758	96.7252	6608
98.5759	7844	98.5759	6603
100.426	7927	100.426	6625
102.278	7952	102.278	6667
104.127	8055	104.127	6671
105.977	8103	105.977	6698
107.826	8147	107.826	6714
109.675	8197	109.675	6773
111.523	8269	111.523	6787
113.371	8351	113.371	6786
115.219	8323	115.219	6861
117.067	8408	117.067	6856

118.914	8395	118.914	6920
120.761	8448	120.761	6963
122.607	8496	122.607	6946
124.454	8561	124.454	7035
126.3	8567	126.3	7022
128.145	8596	128.145	7063
129.989	8638	129.989	7052
131.834	8671	131.834	6954
133.679	8738	133.679	6870
135.523	8782	135.523	6848
137.366	8812	137.366	6896
139.209	8818	139.209	6917
141.053	8768	141.053	6972
142.896	8774	142.896	7084
144.737	8746	144.737	7166
146.58	8713	146.58	7283
148.421	8784	148.421	7316
150.263	8785	150.263	7378
152.104	8865	152.104	7367
153.944	8830	153.944	7305
155.785	8834	155.785	7156
157.624	8801	157.624	7138
159.464	8888	159.464	7135
161.303	8846	161.303	7210
163.143	8814	163.143	7285
164.981	8818	164.981	7364
166.818	8808	166.818	7438
168.657	8832	168.657	7408
170.494	8880	170.494	7334
172.331	8860	172.331	7238
174.168	8874	174.168	7091
176.004	8897	176.004	7089
177.84	8806	177.84	7045
179.676	8835	179.676	6960
181.512	8877	181.512	6889
183.347	8898	183.347	6880

185.182	8972	185.182	6871
187.016	9029	187.016	6868
188.85	9084	188.85	6842
190.683	9118	190.683	6865
192.516	9168	192.516	6938
194.349	9232	194.349	6999
196.182	9298	196.182	7008
198.014	9311	198.014	7066
199.846	9283	199.846	7122
201.678	9357	201.678	7086
203.51	9232	203.51	7167
205.341	9250	205.341	7118
207.171	9145	207.171	7139
209.002	9082	209.002	7003
210.832	9045	210.832	6929
212.662	9150	212.662	6932
214.49	9062	214.49	6922
216.319	9105	216.319	6961
218.148	9106	218.148	6954
219.977	9103	219.977	6974
221.804	9193	221.804	6950
223.632	9220	223.632	6963
225.459	9254	225.459	6995
227.285	9269	227.285	7006
229.112	9418	229.112	6936
230.939	9460	230.939	6916
232.764	9513	232.764	6872
234.59	9574	234.59	6871
236.415	9692	236.415	6963
238.24	9809	238.24	6928
240.064	9934	240.064	6933
241.889	9943	241.889	6976
243.712	9823	243.712	7017
245.535	9650	245.535	7049
247.359	9555	247.359	7064
249.181	9479	249.181	7092

251.003	9424	251.003	7123
252.826	9371	252.826	7166
254.647	9297	254.647	7236
256.468	9339	256.468	7274
258.291	9404	258.291	7330
260.111	9339	260.111	7310
261.931	9411	261.931	7214
263.751	9333	263.751	7129
265.57	9316	265.57	7075
267.389	9408	267.389	6990
269.21	9422	269.21	6961
271.028	9420	271.028	6951
272.847	9485	272.847	6955
274.664	9453	274.664	6966
276.482	9485	276.482	6964
278.299	9510	278.299	6973
280.116	9597	280.116	7007
281.933	9554	281.933	7051
283.75	9488	283.75	7091
285.564	9544	285.564	7136
287.38	9547	287.38	7186
289.196	9557	289.196	7181
291.011	9520	291.011	7178
292.826	9583	292.826	7256
294.64	9658	294.64	7218
296.453	9750	296.453	7217
298.267	9700	298.267	7237
300.081	9751	300.081	7249
301.893	9741	301.893	7216
303.706	9784	303.706	7170
305.518	9733	305.518	7150
307.329	9806	307.329	7032
309.142	9729	309.142	6983
310.952	9734	310.952	6876
312.763	9772	312.763	6831
314.575	9800	314.575	6842

316.384	9798	316.384	6798
318.193	9870	318.193	6804
320.004	9854	320.004	6811
321.812	10001	321.812	6836
323.622	10005	323.622	6859
325.43	10157	325.43	6829
327.238	10181	327.238	6825
329.046	10193	329.046	6889
330.853	10305	330.853	6860
332.66	10481	332.66	6861
334.468	10633	334.468	6891
336.274	10790	336.274	6859
338.08	10971	338.08	6827
339.886	11177	339.886	6823
341.691	11406	341.691	6815
343.497	11647	343.497	6819
345.302	11644	345.302	6819
347.106	11670	347.106	6842
348.91	11485	348.91	6873
350.714	11111	350.714	6915
352.517	10777	352.517	6900
354.32	10462	354.32	6974
356.123	10199	356.123	6983
357.926	10125	357.926	7000
359.728	9970	359.728	7012
361.53	9927	361.53	7080
363.331	9963	363.331	7086
365.131	9867	365.131	7118
366.932	9848	366.932	7168
368.733	9867	368.733	7198
370.533	9868	370.533	7146
372.334	9899	372.334	7121
374.132	9941	374.132	7066
375.931	9933	375.931	6993
377.731	9971	377.731	6984
379.528	10044	379.528	6948

381.327	10106	381.327	6916
383.125	10153	383.125	6951
384.921	10220	384.921	6955
386.719	10343	386.719	6952
388.515	10341	388.515	6973
390.312	10300	390.312	6989
392.108	10200	392.108	6988
393.904	10285	393.904	6979
395.699	10337	395.699	6997
397.495	10440	397.495	7028
399.289	10557	399.289	7045
401.084	10626	401.084	7067
402.878	10685	402.878	7039
404.671	10744	404.671	7005
406.465	10645	406.465	7033
408.258	10645	408.258	7058
410.05	10557	410.05	7019
411.842	10585	411.842	7082
413.636	10543	413.636	7084
415.427	10574	415.427	7087
417.218	10631	417.218	7161
419.009	10636	419.009	7227
420.8	10719	420.8	7263
422.59	10709	422.59	7284
424.38	10592	424.38	7319
426.169	10500	426.169	7283
427.959	10433	427.959	7255
429.748	10393	429.748	7222
431.537	10333	431.537	7166
433.325	10203	433.325	7098
435.113	10252	435.113	7062
436.901	10203	436.901	7058
438.689	10299	438.689	7090
440.476	10174	440.476	7011
442.263	10275	442.263	7024
444.048	10303	444.048	7025

445.835	10296	445.835	7013
447.621	10302	447.621	7028
449.406	10351	449.406	6973
451.191	10371	451.191	6958
452.976	10375	452.976	6958
454.761	10371	454.761	6970
456.544	10408	456.544	6977
458.328	10415	458.328	6953
460.111	10387	460.111	6951
461.894	10447	461.894	7007
463.676	10422	463.676	6963
465.46	10404	465.46	6975
467.241	10448	467.241	6962
469.023	10462	469.023	7032
470.804	10451	470.804	7012
472.586	10505	472.586	7032
474.366	10514	474.366	7035
476.146	10452	476.146	7044
477.927	10504	477.927	6998
479.707	10523	479.707	7001
481.486	10475	481.486	7014
483.266	10546	483.266	7011
485.044	10516	485.044	7012
486.822	10553	486.822	6999
488.6	10576	488.6	7011
490.378	10563	490.378	7030
492.156	10660	492.156	7033
493.933	10679	493.933	7070
495.71	10565	495.71	7074
497.486	10629	497.486	7081
499.262	10588	499.262	7115
501.038	10632	501.038	7176
502.814	10657	502.814	7193
504.589	10724	504.589	7251
506.364	10621	506.364	7362
508.138	10699	508.138	7401

509.913	10739	509.913	7497
511.685	10834	511.685	7590
513.459	10760	513.459	7739
515.232	10904	515.232	7791
517.005	10882	517.005	7819
518.778	10961	518.778	7845
520.549	11032	520.549	7706
522.322	11020	522.322	7642
524.093	11098	524.093	7618
525.864	11150	525.864	7617
527.635	11192	527.635	7650
529.406	11228	529.406	7758
531.175	11141	531.175	7838
532.946	11207	532.946	7951
534.715	11131	534.715	8069
536.485	11190	536.485	8136
538.253	11130	538.253	8184
540.022	11134	540.022	8153
541.79	11120	541.79	8007
543.558	11193	543.558	7868
545.325	11147	545.325	7808
547.092	11202	547.092	7754
548.86	11166	548.86	7777
550.626	11232	550.626	7792
552.392	11168	552.392	7816
554.159	11171	554.159	7807
555.924	11194	555.924	7843
557.689	11244	557.689	7815
559.454	11167	559.454	7721
561.218	11145	561.218	7680
562.984	11241	562.984	7624
564.747	11263	564.747	7602
566.511	11170	566.511	7539
568.274	11267	568.274	7541
570.037	11295	570.037	7521
571.8	11434	571.8	7558

573.562	11409	573.562	7511
575.324	11344	575.324	7559
577.086	11533	577.086	7604
578.847	11500	578.847	7571
580.608	11582	580.608	7669
582.368	11570	582.368	7630
584.128	11575	584.128	7656
585.889	11593	585.889	7724
587.649	11467	587.649	7733
589.408	11501	589.408	7762
591.166	11538	591.166	7819
592.925	11449	592.925	7830
594.684	11393	594.684	7857
596.441	11567	596.441	7819
598.2	11508	598.2	7758
599.958	11549	599.958	7781
601.714	11519	601.714	7755
603.471	11512	603.471	7685
605.227	11500	605.227	7714
606.984	11627	606.984	7747
608.739	11547	608.739	7719
610.495	11551	610.495	7666
612.25	11597	612.25	7726
614.005	11626	614.005	7701
615.759	11602	615.759	7674
617.513	11594	617.513	7643
619.268	11605	619.268	7658
621.021	11672	621.021	7677
622.774	11722	622.774	7662
624.527	11718	624.527	7652
626.28	11710	626.28	7688
628.032	11822	628.032	7713
629.783	11784	629.783	7713
631.534	11848	631.534	7747
633.286	11866	633.286	7729
635.036	11978	635.036	7793

636.788	11900	636.788	7856
638.538	11962	638.538	7842
640.288	12056	640.288	7993
642.038	12075	642.038	8077
643.787	12143	643.787	8215
645.536	12228	645.536	8328
647.284	12387	647.284	8548
649.032	12443	649.032	8816
650.78	12524	650.78	9082
652.528	12702	652.528	9503
654.276	12857	654.276	9883
656.023	13060	656.023	10368
657.769	13267	657.769	10673
659.515	13576	659.515	10803
661.262	13767	661.262	10780
663.008	13958	663.008	10437
664.752	14084	664.752	9957
666.498	14190	666.498	9454
668.242	14210	668.242	9167
669.987	13995	669.987	8980
671.732	13925	671.732	8803
673.475	13778	673.475	8833
675.219	13737	675.219	8771
676.961	13967	676.961	8781
678.705	14056	678.705	8745
680.447	14328	680.447	8760
682.188	14559	682.188	8726
683.931	14780	683.931	8800
685.672	14927	685.672	8724
687.413	14989	687.413	8670
689.155	14901	689.155	8685
690.895	14753	690.895	8686
692.635	14422	692.635	8662
694.376	14015	694.376	8649
696.115	13571	696.115	8598
697.854	13277	697.854	8519

699.593	13173	699.593	8516
701.331	13028	701.331	8541
703.07	12935	703.07	8510
704.808	12910	704.808	8521
706.545	12818	706.545	8503
708.282	12885	708.282	8418
710.019	12838	710.019	8461
711.756	12842	711.756	8429
713.493	12812	713.493	8376
715.229	12865	715.229	8410
716.965	12892	716.965	8386
718.7	12936	718.7	8421
720.436	13053	720.436	8380
722.171	12989	722.171	8384
723.904	12964	723.904	8337
725.639	12978	725.639	8420
727.373	12973	727.373	8405
729.105	13072	729.105	8459
730.839	13017	730.839	8526
732.572	13078	732.572	8473
734.304	13111	734.304	8504
736.037	13136	736.037	8486
737.769	13171	737.769	8545
739.5	13128	739.5	8566
741.232	13258	741.232	8635
742.962	13154	742.962	8665
744.693	13109	744.693	8720
746.423	13255	746.423	8745
748.153	13278	748.153	8770
749.883	13294	749.883	8848
751.612	13362	751.612	8823
753.342	13369	753.342	8849
755.07	13406	755.07	8827
756.798	13476	756.798	8896
758.526	13404	758.526	9010
760.255	13460	760.255	9057

761.982	13484	761.982	9104
763.709	13408	763.709	9130
765.435	13536	765.435	9272
767.161	13435	767.161	9256
768.887	13549	768.887	9355
770.613	13560	770.613	9371
772.339	13610	772.339	9479
774.064	13625	774.064	9498
775.789	13626	775.789	9601
777.513	13594	777.513	9712
779.237	13673	779.237	9730
780.961	13725	780.961	9730
782.685	13747	782.685	9739
784.409	13768	784.409	9783
786.132	13788	786.132	9756
787.855	13797	787.855	9814
789.576	13768	789.576	9810
791.298	13815	791.298	9891
793.02	13789	793.02	9839
794.742	13915	794.742	9855
796.462	13935	796.462	9842
798.184	13958	798.184	9884
799.903	14003	799.903	9825
801.624	13958	801.624	9834
803.344	14130	803.344	9874
805.063	14077	805.063	9873
806.783	14100	806.783	9905
808.501	14225	808.501	9904
810.22	14287	810.22	9925
811.938	14223	811.938	9871
813.655	14230	813.655	10004
815.373	14321	815.373	10003
817.09	14400	817.09	10054
818.807	14408	818.807	10083
820.524	14439	820.524	10205
822.24	14659	822.24	10254

823.956	14503	823.956	10436
825.671	14467	825.671	10533
827.387	14576	827.387	10693
829.102	14588	829.102	10998
830.817	14602	830.817	11271
832.531	14600	832.531	11762
834.245	14633	834.245	12424
835.959	14667	835.959	13063
837.672	14771	837.672	13968
839.385	14804	839.385	14947
841.098	14831	841.098	16089
842.811	14952	842.811	17320
844.523	15001	844.523	18506
846.235	15031	846.235	19188
847.947	15115	847.947	19364
849.658	15231	849.658	18997
851.368	15389	851.368	18867
853.079	15575	853.079	19447
854.789	15505	854.789	20023
856.5	15537	856.5	20884
858.208	15598	858.208	21295
859.918	15511	859.918	20633
861.628	15374	861.628	17878
863.335	15391	863.335	14883
865.044	15222	865.044	12761
866.752	15274	866.752	11767
868.46	15283	868.46	11335
870.167	15321	870.167	11139
871.875	15308	871.875	11013
873.581	15297	873.581	10902
875.288	15410	875.288	10825
876.994	15428	876.994	10734
878.7	15343	878.7	10616
880.406	15358	880.406	10576
882.11	15432	882.11	10618
883.816	15508	883.816	10615

885.52	15563	885.52	10739
887.224	15506	887.224	10830
888.928	15525	888.928	10983
890.631	15421	890.631	11271
892.336	15624	892.336	11455
894.039	15618	894.039	11738
895.741	15594	895.741	11839
897.444	15667	897.444	11856
899.146	15715	899.146	11677
900.847	15805	900.847	11311
902.549	15747	902.549	10949
904.25	15812	904.25	10703
905.951	15870	905.951	10684
907.652	15925	907.652	10631
909.352	16002	909.352	10697
911.052	16032	911.052	10728
912.751	16058	912.751	10766
914.45	16072	914.45	10742
916.15	16217	916.15	10911
917.849	16285	917.849	10927
919.546	16336	919.546	10971
921.244	16367	921.244	10981
922.943	16434	922.943	11030
924.639	16700	924.639	11032
926.337	16611	926.337	11077
928.034	16812	928.034	11204
929.73	16851	929.73	11252
931.427	16919	931.427	11239
933.122	16930	933.122	11479
934.818	16906	934.818	11488
936.513	16948	936.513	11488
938.207	16912	938.207	11599
939.902	16967	939.902	11684
941.596	16965	941.596	11658
943.291	16867	943.291	11833
944.984	16727	944.984	11781

946.677	16925	946.677	11874
948.37	16741	948.37	11930
950.064	16845	950.064	12063
951.756	16892	951.756	12053
953.448	16889	953.448	12080
955.139	16835	955.139	12095
956.831	16863	956.831	12100
958.522	16886	958.522	12017
960.212	16893	960.212	12036
961.903	16786	961.903	12029
963.593	16994	963.593	12000
965.283	16990	965.283	12136
966.973	16848	966.973	12198
968.662	16946	968.662	12289
970.351	17027	970.351	12433
972.04	17061	972.04	12613
973.729	17092	973.729	12899
975.417	17143	975.417	13191
977.104	17088	977.104	13478
978.792	17149	978.792	13803
980.479	17285	980.479	14166
982.165	17294	982.165	14439
983.852	17241	983.852	14767
985.539	17491	985.539	14739
987.224	17493	987.224	14569
988.91	17577	988.91	14045
990.594	17714	990.594	13470
992.28	17819	992.28	13056
993.965	18113	993.965	12840
995.649	18358	995.649	12724
997.332	18514	997.332	12619
999.017	18805	999.017	12688
1000.7	19389	1000.7	12494
1002.38	19862	1002.38	12504
1004.07	20357	1004.07	12295
1005.75	20912	1005.75	12247

1007.43	21529	1007.43	12182
1009.11	22234	1009.11	12051
1010.79	22805	1010.79	12044
1012.48	23406	1012.48	11974
1014.16	23671	1014.16	11934
1015.84	23679	1015.84	12000
1017.52	23405	1017.52	11838
1019.2	22820	1019.2	11913
1020.88	22250	1020.88	11971
1022.56	21916	1022.56	11925
1024.24	21804	1024.24	11975
1025.91	21906	1025.91	12028
1027.59	22154	1027.59	11961
1029.27	22333	1029.27	12194
1030.95	22485	1030.95	12254
1032.63	22622	1032.63	12472
1034.3	22572	1034.3	12619
1035.98	22697	1035.98	12745
1037.66	22401	1037.66	13054
1039.33	21982	1039.33	13192
1041.01	21526	1041.01	13422
1042.69	21152	1042.69	13602
1044.36	20528	1044.36	13665
1046.04	20340	1046.04	13607
1047.71	19994	1047.71	13293
1049.38	19648	1049.38	13011
1051.06	19284	1051.06	12824
1052.73	19150	1052.73	12576
1054.41	18913	1054.41	12537
1056.08	18831	1056.08	12330
1057.75	18931	1057.75	12392
1059.43	18879	1059.43	12425
1061.1	18794	1061.1	12457
1062.77	18762	1062.77	12427
1064.44	18647	1064.44	12314
1066.11	18738	1066.11	12351

1067.78	18701	1067.78	12315
1069.45	18783	1069.45	12203
1071.12	18681	1071.12	12226
1072.79	18874	1072.79	12157
1074.46	18845	1074.46	12102
1076.13	18794	1076.13	12135
1077.8	18834	1077.8	12084
1079.47	18832	1079.47	12095
1081.14	18789	1081.14	12044
1082.81	18867	1082.81	12053
1084.48	18808	1084.48	12029
1086.14	18962	1086.14	11998
1087.81	19077	1087.81	12009
1089.48	18958	1089.48	11913
1091.15	18974	1091.15	12069
1092.81	19174	1092.81	11968
1094.48	19059	1094.48	11971
1096.14	19192	1096.14	11964
1097.81	19207	1097.81	11986
1099.48	19139	1099.48	11989
1101.14	19294	1101.14	11973
1102.81	19284	1102.81	11988
1104.47	19393	1104.47	11967
1106.13	19415	1106.13	12021
1107.8	19427	1107.8	11899
1109.46	19451	1109.46	11964
1111.12	19420	1111.12	11936
1112.79	19522	1112.79	11893
1114.45	19571	1114.45	11930
1116.11	19718	1116.11	11950
1117.77	19669	1117.77	11882
1119.44	19702	1119.44	11872
1121.1	19775	1121.1	11772
1122.76	19689	1122.76	11764
1124.42	19859	1124.42	11727
1126.08	19834	1126.08	11763

1127.74	19892	1127.74	11762
1129.4	19877	1129.4	11681
1131.06	19869	1131.06	11718
1132.72	19958	1132.72	11665
1134.38	19887	1134.38	11586
1136.03	19959	1136.03	11553
1137.69	19813	1137.69	11522
1139.35	19843	1139.35	11442
1141.01	20018	1141.01	11502
1142.67	19917	1142.67	11470
1144.32	19966	1144.32	11400
1145.98	19962	1145.98	11401
1147.64	20078	1147.64	11397
1149.29	20035	1149.29	11419
1150.95	20003	1150.95	11376
1152.6	19950	1152.6	11392
1154.26	20050	1154.26	11368
1155.91	20100	1155.91	11368
1157.57	20085	1157.57	11486
1159.22	20160	1159.22	11413
1160.88	20113	1160.88	11435
1162.53	20168	1162.53	11401
1164.18	20213	1164.18	11444
1165.84	20252	1165.84	11456
1167.49	20239	1167.49	11477
1169.14	20387	1169.14	11528
1170.79	20313	1170.79	11611
1172.45	20303	1172.45	11579
1174.1	20267	1174.1	11622
1175.75	20369	1175.75	11601
1177.4	20456	1177.4	11626
1179.05	20410	1179.05	11764
1180.7	20415	1180.7	11706
1182.35	20585	1182.35	11802
1184	20528	1184	11809
1185.65	20622	1185.65	11808

1187.3	20611	1187.3	11825
1188.95	20634	1188.95	11883
1190.6	20581	1190.6	11955
1192.25	20614	1192.25	11964
1193.89	20624	1193.89	12165
1195.54	20662	1195.54	12124
1197.19	20646	1197.19	12161
1198.84	20652	1198.84	12218
1200.48	20749	1200.48	12149
1202.13	20859	1202.13	12211
1203.78	20800	1203.78	12256
1205.42	20877	1205.42	12283
1207.07	20978	1207.07	12360
1208.71	20936	1208.71	12347
1210.36	20919	1210.36	12385
1212	21011	1212	12449
1213.65	21020	1213.65	12554
1215.29	20962	1215.29	12439
1216.93	21029	1216.93	12509
1218.58	21152	1218.58	12615
1220.22	21163	1220.22	12640
1221.86	21049	1221.86	12638
1223.51	21217	1223.51	12737
1225.15	21342	1225.15	12738
1226.79	21342	1226.79	12828
1228.43	21295	1228.43	12740
1230.07	21428	1230.07	12975
1231.71	21436	1231.71	12982
1233.35	21344	1233.35	13080
1235	21469	1235	13025
1236.64	21419	1236.64	13123
1238.27	21518	1238.27	13210
1239.91	21479	1239.91	13143
1241.55	21441	1241.55	13240
1243.19	21393	1243.19	13424
1244.83	21533	1244.83	13483

1246.47	21532	1246.47	13623
1248.11	21574	1248.11	13787
1249.75	21609	1249.75	13909
1251.38	21580	1251.38	14076
1253.02	21702	1253.02	14250
1254.66	21708	1254.66	14579
1256.29	21501	1256.29	14690
1257.93	21530	1257.93	14860
1259.57	21762	1259.57	15151
1261.2	21862	1261.2	15497
1262.84	21774	1262.84	15718
1264.47	21849	1264.47	16055
1266.11	21921	1266.11	16019
1267.74	21871	1267.74	16239
1269.37	22050	1269.37	16277
1271.01	21942	1271.01	16331
1272.64	22019	1272.64	16250
1274.28	21961	1274.28	16140
1275.91	21976	1275.91	16004
1277.54	22019	1277.54	15919
1279.17	22112	1279.17	15749
1280.81	22161	1280.81	15692
1282.44	22103	1282.44	15608
1284.07	22217	1284.07	15578
1285.7	22086	1285.7	15535
1287.33	22247	1287.33	15477
1288.96	22315	1288.96	15680
1290.59	22277	1290.59	15594
1292.22	22337	1292.22	15699
1293.85	22427	1293.85	15712
1295.48	22461	1295.48	15911
1297.11	22588	1297.11	16202
1298.74	22656	1298.74	16442
1300.37	22687	1300.37	16645
1302	22590	1302	17132
1303.62	22803	1303.62	17659

1305.25	22941	1305.25	18412
1306.88	22959	1306.88	19362
1308.51	23023	1308.51	20768
1310.13	23090	1310.13	22459
1311.76	23328	1311.76	25117
1313.38	23558	1313.38	29351
1315.01	23892	1315.01	36130
1316.64	24466	1316.64	48545
1318.26	25771	1318.26	70770
1319.89	27588	1319.89	103961
1321.51	29707	1321.51	149195
1323.14	32671	1323.14	204388
1324.76	37039	1324.76	279829
1326.38	43053	1326.38	384756
1328.01	50996	1328.01	535703
1329.63	60222	1329.63	652982
1331.25	70197	1331.25	652982
1332.87	79066	1332.87	652982
1334.5	84389	1334.5	652982
1336.12	77942	1336.12	652982
1337.74	60897	1337.74	652982
1339.36	44340	1339.36	350917
1340.98	34083	1340.98	164956
1342.6	28802	1342.6	87172
1344.22	26202	1344.22	54784
1345.84	25045	1345.84	39826
1347.47	24463	1347.47	31688
1349.09	24317	1349.09	26824
1350.7	24168	1350.7	23552
1352.32	23940	1352.32	21281
1353.94	23809	1353.94	19478
1355.56	23628	1355.56	18234
1357.18	23694	1357.18	17268
1358.8	23752	1358.8	16473
1360.41	23794	1360.41	15802
1362.03	23899	1362.03	15273

1363.65	23706	1363.65	14962
1365.26	23666	1365.26	14580
1366.88	23739	1366.88	14276
1368.5	23818	1368.5	13964
1370.11	23896	1370.11	13805
1371.73	23740	1371.73	13574
1373.34	23826	1373.34	13442
1374.96	23783	1374.96	13363
1376.57	23656	1376.57	13246
1378.19	23875	1378.19	13252
1379.8	23974	1379.8	13143
1381.41	24088	1381.41	13010
1383.03	23993	1383.03	13017
1384.64	23925	1384.64	12964
1386.25	24102	1386.25	12881
1387.87	23956	1387.87	12904
1389.48	24087	1389.48	12942
1391.09	23996	1391.09	12963
1392.7	24118	1392.7	13049
1394.31	24204	1394.31	12997
1395.93	24190	1395.93	13026
1397.54	24146	1397.54	13106
1399.15	24136	1399.15	13223
1400.76	24330	1400.76	13193
1402.37	24238	1402.37	13247
1403.98	24204	1403.98	13351
1405.59	24367	1405.59	13383
1407.2	24120	1407.2	13468
1408.8	24422	1408.8	13471
1410.41	24255	1410.41	13561
1412.02	24340	1412.02	13659
1413.63	24246	1413.63	13694
1415.24	24350	1415.24	13692
1416.84	24282	1416.84	13647
1418.45	24403	1418.45	13605
1420.06	24411	1420.06	13733

1421.66	24510	1421.66	13720
1423.27	24354	1423.27	13562
1424.88	24497	1424.88	13612
1426.48	24489	1426.48	13592
1428.09	24624	1428.09	13646
1429.69	24604	1429.69	13691
1431.29	24544	1431.29	13600
1432.9	24617	1432.9	13672
1434.5	24656	1434.5	13689
1436.11	24753	1436.11	13717
1437.71	24711	1437.71	13814
1439.31	24821	1439.31	13839
1440.92	24776	1440.92	14062
1442.52	24971	1442.52	14201
1444.12	24830	1444.12	14270
1445.72	24782	1445.72	14469
1447.33	24754	1447.33	14765
1448.93	24801	1448.93	15013
1450.53	24883	1450.53	15311
1452.13	24987	1452.13	15630
1453.73	24940	1453.73	15858
1455.33	25009	1455.33	16232
1456.93	24945	1456.93	16611
1458.53	25027	1458.53	17044
1460.13	25176	1460.13	17507
1461.73	25096	1461.73	17813
1463.33	25164	1463.33	18327
1464.92	25012	1464.92	18740
1466.52	24985	1466.52	19024
1468.12	25346	1468.12	19284
1469.72	25159	1469.72	19574
1471.32	25289	1471.32	19811
1472.91	25309	1472.91	19792
1474.51	25382	1474.51	19842
1476.11	25330	1476.11	19617
1477.7	25145	1477.7	19606

1479.3	25520	1479.3	19209
1480.89	25483	1480.89	18799
1482.49	25415	1482.49	18410
1484.09	25506	1484.09	18079
1485.68	25596	1485.68	17611
1487.27	25552	1487.27	17137
1488.87	25539	1488.87	16460
1490.46	25610	1490.46	16208
1492.06	25696	1492.06	15591
1493.65	25588	1493.65	15200
1495.24	25715	1495.24	14867
1496.83	25767	1496.83	14470
1498.43	25768	1498.43	14159
1500.02	25991	1500.02	13789
1501.61	26083	1501.61	13432
1503.2	25896	1503.2	13156
1504.79	25905	1504.79	12867
1506.39	25883	1506.39	12601
1507.98	25958	1507.98	12386
1509.57	26007	1509.57	12169
1511.16	26110	1511.16	12049
1512.75	26094	1512.75	11925
1514.34	26019	1514.34	11779
1515.92	26091	1515.92	11540
1517.51	26098	1517.51	11474
1519.1	26176	1519.1	11311
1520.69	26165	1520.69	11202
1522.28	26438	1522.28	11184
1523.87	26330	1523.87	11033
1525.45	26204	1525.45	10876
1527.04	26324	1527.04	10918
1528.63	26481	1528.63	10890
1530.21	26410	1530.21	10749
1531.8	26475	1531.8	10704
1533.39	26627	1533.39	10690
1534.97	26647	1534.97	10624

1536.56	26638	1536.56	10558
1538.14	26518	1538.14	10510
1539.73	26453	1539.73	10430
1541.31	26661	1541.31	10432
1542.9	26695	1542.9	10421
1544.48	26763	1544.48	10424
1546.06	26782	1546.06	10348
1547.65	26859	1547.65	10376
1549.23	26861	1549.23	10364
1550.81	26917	1550.81	10337
1552.4	26907	1552.4	10261
1553.98	26967	1553.98	10291
1555.56	27066	1555.56	10345
1557.14	26896	1557.14	10343
1558.73	26960	1558.73	10215
1560.31	26886	1560.31	10237
1561.89	27073	1561.89	10194
1563.47	27099	1563.47	10114
1565.05	27149	1565.05	10110
1566.63	27208	1566.63	10123
1568.21	27157	1568.21	10121
1569.79	27349	1569.79	10077
1571.37	27107	1571.37	10040
1572.94	27188	1572.94	10052
1574.52	27434	1574.52	10077
1576.1	27388	1576.1	9971
1577.68	27264	1577.68	10006
1579.26	27388	1579.26	9923
1580.84	27359	1580.84	9966
1582.41	27438	1582.41	9971
1583.99	27599	1583.99	9983
1585.57	27390	1585.57	9949
1587.14	27344	1587.14	9970
1588.72	27325	1588.72	9938
1590.29	27700	1590.29	9956
1591.87	27585	1591.87	9923

1593.44	27772		1593.44	9887
1595.02	27633		1595.02	9898
1596.59	27916		1596.59	9824
1598.17	27912		1598.17	9876
1599.74	27961		1599.74	9964
1601.32	27725		1601.32	9927
1602.89	27871		1602.89	9921
1604.46	27932		1604.46	10006
1606.04	28020		1606.04	9952
1607.61	28031		1607.61	9930
1609.18	28103		1609.18	9970
1610.75	28169		1610.75	9930
1612.32	28226		1612.32	9995
1613.9	28109		1613.9	10024
1615.47	28301		1615.47	10052
1617.04	28352		1617.04	10040
1618.61	28432		1618.61	10061
1620.18	28211		1620.18	10106
1621.75	28378		1621.75	10076
1623.32	28547		1623.32	10074
1624.89	28293		1624.89	10089
1626.46	28569		1626.46	10052
1628.03	28509		1628.03	10206
1629.59	28733		1629.59	10039
1631.16	28913		1631.16	10072
1632.73	28569		1632.73	10124
1634.3	28813		1634.3	10053
1635.87	28823		1635.87	10067
1637.43	28810		1637.43	9990
1639	28783		1639	9980
1640.57	28990		1640.57	9904
1642.13	29065		1642.13	9893
1643.7	29208		1643.7	9888
1645.27	29064		1645.27	9810
1646.83	29175		1646.83	9836
1648.4	29216		1648.4	9762

1649.96	29091	1649.96	9696
1651.53	29167	1651.53	9654
1653.09	29143	1653.09	9667
1654.65	29279	1654.65	9615
1656.22	29310	1656.22	9575
1657.78	29273	1657.78	9611
1659.34	29417	1659.34	9484
1660.91	29607	1660.91	9523
1662.47	29395	1662.47	9492
1664.03	29658	1664.03	9498
1665.59	29558	1665.59	9398
1667.16	29579	1667.16	9429
1668.72	29490	1668.72	9367
1670.28	29597	1670.28	9387
1671.84	29696	1671.84	9367
1673.4	29426	1673.4	9339
1674.96	29630	1674.96	9305
1676.52	29725	1676.52	9299
1678.08	29576	1678.08	9250
1679.64	29680	1679.64	9266
1681.2	29627	1681.2	9241
1682.76	29639	1682.76	9282
1684.32	29760	1684.32	9279
1685.88	29593	1685.88	9281
1687.43	29912	1687.43	9203
1688.99	29746	1688.99	9193
1690.55	29807	1690.55	9237
1692.11	29776	1692.11	9195
1693.66	29884	1693.66	9157
1695.22	29653	1695.22	9126
1696.78	29720	1696.78	9118
1698.33	29682	1698.33	9142
1699.89	29650	1699.89	9130
1701.45	29797	1701.45	9120
1703	29676	1703	9088
1704.56	29732	1704.56	9013

1706.11	29692	1706.11	9081
1707.66	29646	1707.66	9063
1709.22	29658	1709.22	9059
1710.77	29665	1710.77	9084
1712.33	29492	1712.33	9050
1713.88	29671	1713.88	8993
1715.43	29678	1715.43	9042
1716.99	29643	1716.99	9029
1718.54	29811	1718.54	9005
1720.09	29868	1720.09	9042
1721.64	29632	1721.64	9039
1723.19	29863	1723.19	9083
1724.75	29742	1724.75	9003
1726.3	29706	1726.3	9034
1727.85	29855	1727.85	9076
1729.4	29833	1729.4	9060
1730.95	29802	1730.95	9020
1732.5	29934	1732.5	9042
1734.05	29887	1734.05	9007
1735.6	29872	1735.6	9049
1737.15	29824	1737.15	9035
1738.69	29942	1738.69	9113
1740.24	29948	1740.24	9029
1741.79	29889	1741.79	9035
1743.34	30157	1743.34	9042
1744.89	29994	1744.89	9070
1746.43	30007	1746.43	9069
1747.98	29981	1747.98	9058
1749.53	30191	1749.53	9044
1751.08	30158	1751.08	9079
1752.62	30218	1752.62	9080
1754.17	30237	1754.17	9062
1755.71	30382	1755.71	9056
1757.26	30116	1757.26	9054
1758.8	30397	1758.8	9032
1760.35	30497	1760.35	9051

1761.89	30420	1761.89	9054
1763.44	30555	1763.44	9020
1764.98	30441	1764.98	9048
1766.53	30507	1766.53	9066
1768.07	30736	1768.07	9069
1769.61	30654	1769.61	9086
1771.16	30673	1771.16	9076
1772.7	30779	1772.7	9093
1774.24	30778	1774.24	9102
1775.78	30877	1775.78	9097
1777.33	30818	1777.33	9100
1778.87	30857	1778.87	9088
1780.41	30985	1780.41	9108
1781.95	30789	1781.95	9140
1783.49	30938	1783.49	9116
1785.03	30858	1785.03	9105
1786.57	30954	1786.57	9116
1788.11	30823	1788.11	9144
1789.65	31032	1789.65	9143
1791.19	30892	1791.19	9101
1792.73	31009	1792.73	9110
1794.27	30832	1794.27	9100
1795.81	31040	1795.81	9121
1797.34	30995	1797.34	9188
1798.88	31227	1798.88	9149
1800.42	31353	1800.42	9149
1801.96	31272	1801.96	9160
1803.49	31095	1803.49	9180
1805.03	31229	1805.03	9165
1806.57	31425	1806.57	9152
1808.11	31210	1808.11	9118
1809.64	31273	1809.64	9164
1811.18	31344	1811.18	9182
1812.71	31531	1812.71	9210
1814.25	31653	1814.25	9210
1815.78	31467	1815.78	9229

1817.32	31524	1817.32	9276
1818.85	31712	1818.85	9225
1820.39	31714	1820.39	9140
1821.92	31833	1821.92	9206
1823.45	31793	1823.45	9215
1824.99	32022	1824.99	9226
1826.52	32036	1826.52	9254
1828.05	32016	1828.05	9220
1829.58	31911	1829.58	9269
1831.12	32019	1831.12	9284
1832.65	32234	1832.65	9286
1834.18	31954	1834.18	9335
1835.71	32209	1835.71	9258
1837.24	32237	1837.24	9296
1838.77	32301	1838.77	9302
1840.3	32325	1840.3	9306
1841.83	32358	1841.83	9329
1843.36	32263	1843.36	9306
1844.89	32435	1844.89	9293
1846.42	32451	1846.42	9351
1847.95	32657	1847.95	9394
1849.48	32712	1849.48	9349
1851.01	32807	1851.01	9300
1852.54	32551	1852.54	9364
1854.07	32589	1854.07	9364
1855.59	32544	1855.59	9386
1857.12	32601	1857.12	9312
1858.65	32740	1858.65	9419
1860.18	32568	1860.18	9336
1861.7	32737	1861.7	9408
1863.23	32666	1863.23	9405
1864.75	32859	1864.75	9453
1866.28	32851	1866.28	9391
1867.81	32638	1867.81	9459
1869.33	32675	1869.33	9429
1870.86	32883	1870.86	9410

1872.38	32806	1872.38	9448
1873.9	32794	1873.9	9399
1875.43	32983	1875.43	9396
1876.95	32917	1876.95	9423
1878.48	32846	1878.48	9440
1880	33015	1880	9438
1881.52	32977	1881.52	9404
1883.05	33217	1883.05	9425
1884.57	33143	1884.57	9503
1886.09	33215	1886.09	9510
1887.61	33069	1887.61	9560
1889.13	33284	1889.13	9500
1890.66	33318	1890.66	9519
1892.18	33282	1892.18	9546
1893.7	33166	1893.7	9598
1895.22	33546	1895.22	9578
1896.74	33340	1896.74	9594
1898.26	33438	1898.26	9614
1899.78	33592	1899.78	9546
1901.3	33682	1901.3	9714
1902.82	33654	1902.82	9619
1904.34	33593	1904.34	9614
1905.86	33684	1905.86	9676
1907.37	33644	1907.37	9690
1908.89	33696	1908.89	9730
1910.41	33997	1910.41	9755
1911.93	33913	1911.93	9768
1913.44	33924	1913.44	9803
1914.96	33818	1914.96	9810
1916.48	34002	1916.48	9866
1918	34022	1918	9843
1919.51	33999	1919.51	9933
1921.03	34175	1921.03	9968
1922.54	34130	1922.54	9950
1924.06	34216	1924.06	10097
1925.57	34257	1925.57	10045

1927.09	34399	1927.09	10158
1928.6	34402	1928.6	10270
1930.12	34697	1930.12	10342
1931.63	34681	1931.63	10365
1933.14	34869	1933.14	10397
1934.66	34809	1934.66	10523
1936.17	34902	1936.17	10643
1937.68	35014	1937.68	10811
1939.2	35072	1939.2	10840
1940.71	35089	1940.71	10963
1942.22	35096	1942.22	11103
1943.73	35383	1943.73	11208
1945.25	35543	1945.25	11465
1946.76	35498	1946.76	11642
1948.27	35536	1948.27	11827
1949.78	35597	1949.78	11976
1951.29	35553	1951.29	12128
1952.8	35638	1952.8	12304
1954.31	35831	1954.31	12542
1955.82	35827	1955.82	12702
1957.33	35861	1957.33	13085
1958.84	35751	1958.84	13240
1960.35	36044	1960.35	13444
1961.86	35977	1961.86	13669
1963.36	36000	1963.36	13772
1964.87	35929	1964.87	14002
1966.38	36048	1966.38	14181
1967.89	35968	1967.89	14362
1969.39	36091	1969.39	14385
1970.9	36055	1970.9	14469
1972.41	36046	1972.41	14507
1973.91	35985	1973.91	14549
1975.42	36148	1975.42	14575
1976.93	36185	1976.93	14573
1978.43	36300	1978.43	14520
1979.94	36224	1979.94	14342

1981.44	36166	1981.44	14317
1982.95	36039	1982.95	14146
1984.45	36285	1984.45	14018
1985.96	36191	1985.96	13828
1987.46	36095	1987.46	13686
1988.96	36308	1988.96	13541
1990.47	36288	1990.47	13446
1991.97	36234	1991.97	13184
1993.47	36249	1993.47	13136
1994.98	36349	1994.98	12896
1996.48	36310	1996.48	12817
1997.98	36419	1997.98	12605
1999.48	36473	1999.48	12498
2000.98	36329	2000.98	12368
2002.49	36469	2002.49	12293
2003.99	36321	2003.99	12123
2005.49	36337	2005.49	12004
2006.99	36423	2006.99	11943
2008.49	36399	2008.49	11736
2009.99	36572	2009.99	11715
2011.49	36512	2011.49	11618
2012.99	36583	2012.99	11572
2014.49	36577	2014.49	11483
2015.98	36663	2015.98	11456
2017.48	36808	2017.48	11301
2018.98	36762	2018.98	11159
2020.48	36592	2020.48	11168
2021.98	36669	2021.98	11118
2023.48	36746	2023.48	11135
2024.97	36852	2024.97	11022
2026.47	36731	2026.47	10847
2027.97	36807	2027.97	10855
2029.46	36723	2029.46	10862
2030.96	36837	2030.96	10788
2032.45	36874	2032.45	10719
2033.95	36914	2033.95	10710

2035.44	36948	2035.44	10664
2036.94	37134	2036.94	10523
2038.44	36888	2038.44	10630
2039.93	36827	2039.93	10469
2041.42	37011	2041.42	10481
2042.92	37034	2042.92	10515
2044.41	37077	2044.41	10444
2045.91	36990	2045.91	10415
2047.4	37031	2047.4	10369
2048.89	37099	2048.89	10288
2050.38	37320	2050.38	10220
2051.88	37154	2051.88	10250
2053.37	37148	2053.37	10212
2054.86	37256	2054.86	10180
2056.35	37159	2056.35	10191
2057.84	37045	2057.84	10178
2059.33	37311	2059.33	10167
2060.83	37212	2060.83	10132
2062.32	37348	2062.32	10047
2063.81	37446	2063.81	10113
2065.3	37294	2065.3	10064
2066.79	37483	2066.79	10057
2068.28	37381	2068.28	10067
2069.77	37500	2069.77	10036
2071.25	37376	2071.25	10013
2072.74	37539	2072.74	10077
2074.23	37411	2074.23	10088
2075.72	37688	2075.72	9980
2077.21	37688	2077.21	10052
2078.69	37487	2078.69	10026
2080.18	37570	2080.18	10021
2081.67	37817	2081.67	9985
2083.16	37821	2083.16	10011
2084.64	37802	2084.64	9983
2086.13	37711	2086.13	9927
2087.61	37899	2087.61	9947

2089.1	38119	2089.1	10012
2090.59	37875	2090.59	9983
2092.07	37983	2092.07	9969
2093.56	38187	2093.56	10005
2095.04	38059	2095.04	9945
2096.52	38282	2096.52	9933
2098.01	37919	2098.01	9990
2099.49	37932	2099.49	10015
2100.98	38380	2100.98	9950
2102.46	38163	2102.46	9952
2103.94	38202	2103.94	9941
2105.43	38173	2105.43	9979
2106.91	38454	2106.91	9960
2108.39	38200	2108.39	9933
2109.87	38449	2109.87	9979
2111.35	38306	2111.35	9953
2112.84	38375	2112.84	9960
2114.32	38579	2114.32	10025
2115.8	38525	2115.8	9970
2117.28	38433	2117.28	10003
2118.76	38357	2118.76	9976
2120.24	38453	2120.24	10008
2121.72	38477	2121.72	9929
2123.2	38528	2123.2	10007
2124.68	38650	2124.68	10012
2126.16	38484	2126.16	9981
2127.64	38724	2127.64	10009
2129.11	38642	2129.11	10021
2130.59	38811	2130.59	10067
2132.07	38707	2132.07	9988
2133.55	38849	2133.55	10003
2135.03	38776	2135.03	10070
2136.5	38966	2136.5	10109
2137.98	38934	2137.98	10101
2139.46	38878	2139.46	10023
2140.93	39050	2140.93	10056

2142.41	38993	2142.41	10094
2143.89	39119	2143.89	10062
2145.36	39232	2145.36	10161
2146.84	39197	2146.84	10118
2148.31	38957	2148.31	10195
2149.79	39439	2149.79	10140
2151.26	39099	2151.26	10149
2152.74	39255	2152.74	10206
2154.21	39432	2154.21	10292
2155.68	39574	2155.68	10213
2157.16	39403	2157.16	10321
2158.63	39273	2158.63	10255
2160.1	39434	2160.1	10367
2161.58	39536	2161.58	10337
2163.05	39682	2163.05	10333
2164.52	39508	2164.52	10372
2165.99	39638	2165.99	10430
2167.46	39641	2167.46	10515
2168.94	39789	2168.94	10515
2170.41	39819	2170.41	10541
2171.88	39650	2171.88	10578
2173.35	40026	2173.35	10677
2174.82	39950	2174.82	10806
2176.29	39864	2176.29	10768
2177.76	39943	2177.76	10836
2179.23	39892	2179.23	10819
2180.7	39875	2180.7	10900
2182.17	40019	2182.17	10917
2183.64	40010	2183.64	10823
2185.1	40206	2185.1	10831
2186.57	40367	2186.57	10824
2188.04	40230	2188.04	10851
2189.51	40298	2189.51	10837
2190.97	40222	2190.97	10830
2192.44	40484	2192.44	10804
2193.91	40354	2193.91	10876

2195.38	40474	2195.38	10750
2196.84	40613	2196.84	10747
2198.31	40545	2198.31	10748
2199.77	40456	2199.77	10877
2201.24	40503	2201.24	10793
2202.71	40755	2202.71	10847
2204.17	40932	2204.17	10801
2205.64	40762	2205.64	10742
2207.1	40921	2207.1	10856
2208.56	40864	2208.56	10904
2210.03	40849	2210.03	10813
2211.49	40963	2211.49	10776
2212.96	41069	2212.96	10845
2214.42	41076	2214.42	10847
2215.88	41084	2215.88	10872
2217.34	41127	2217.34	10904
2218.81	40990	2218.81	10851
2220.27	41092	2220.27	10915
2221.73	41001	2221.73	10920
2223.19	41454	2223.19	10888
2224.66	41278	2224.66	11010
2226.12	41388	2226.12	11033
2227.58	41266	2227.58	11073
2229.04	41542	2229.04	11069
2230.5	41231	2230.5	11090
2231.96	41332	2231.96	11099
2233.42	41253	2233.42	11134
2234.88	41298	2234.88	11187
2236.34	41202	2236.34	11178
2237.8	41423	2237.8	11254
2239.25	41277	2239.25	11219
2240.71	41520	2240.71	11314
2242.17	41369	2242.17	11317
2243.63	41672	2243.63	11363
2245.09	41658	2245.09	11420
2246.55	41688	2246.55	11451

2248	41801	2248	11388
2249.46	41618	2249.46	11478
2250.92	41767	2250.92	11573
2252.37	41663	2252.37	11568
2253.83	41851	2253.83	11712
2255.28	41866	2255.28	11711
2256.74	41840	2256.74	11722
2258.2	42046	2258.2	11766
2259.65	42126	2259.65	11859
2261.11	41964	2261.11	11894
2262.56	41798	2262.56	11807
2264.01	41903	2264.01	11874
2265.47	42114	2265.47	11857
2266.92	42285	2266.92	11860
2268.38	42412	2268.38	11872
2269.83	42327	2269.83	11904
2271.28	42298	2271.28	11938
2272.74	42217	2272.74	12024
2274.19	42249	2274.19	12044
2275.64	42382	2275.64	12074
2277.09	42432	2277.09	12105
2278.54	42474	2278.54	11953
2280	42417	2280	12111
2281.45	42606	2281.45	12165
2282.9	42637	2282.9	12181
2284.35	42608	2284.35	12273
2285.8	42624	2285.8	12301
2287.25	42699	2287.25	12252
2288.7	42566	2288.7	12355
2290.15	42749	2290.15	12351
2291.6	42407	2291.6	12369
2293.05	42712	2293.05	12381
2294.5	42635	2294.5	12498
2295.95	42645	2295.95	12494
2297.39	42748	2297.39	12554
2298.84	42527	2298.84	12530

2300.29	42524	2300.29	12649
2301.74	42761	2301.74	12598
2303.18	42624	2303.18	12595
2304.63	42543	2304.63	12665
2306.08	42214	2306.08	12830
2307.53	42649	2307.53	12751
2308.97	42556	2308.97	12842
2310.42	42726	2310.42	12867
2311.87	42838	2311.87	12880
2313.31	42809	2313.31	12877
2314.75	42711	2314.75	12917
2316.2	42547	2316.2	12948
2317.65	42752	2317.65	13011
2319.09	42696	2319.09	13014
2320.54	42168	2320.54	13097
2321.98	42522	2321.98	13112
2323.42	42727	2323.42	13167
2324.87	42605	2324.87	13165
2326.31	42804	2326.31	13236
2327.75	42492	2327.75	13353
2329.2	42557	2329.2	13310
2330.64	42743	2330.64	13367
2332.08	42772	2332.08	13391
2333.52	42573	2333.52	13407
2334.96	42688	2334.96	13448
2336.4	42776	2336.4	13487
2337.85	42842	2337.85	13423
2339.29	42814	2339.29	13437
2340.73	42623	2340.73	13490
2342.17	42874	2342.17	13533
2343.61	42706	2343.61	13521
2345.05	42715	2345.05	13444
2346.49	42715	2346.49	13543
2347.93	42773	2347.93	13537
2349.37	42719	2349.37	13516
2350.81	42818	2350.81	13472

2352.24	42664	2352.24	13492
2353.68	42765	2353.68	13511
2355.12	42808	2355.12	13546
2356.56	42669	2356.56	13519
2358	42746	2358	13651
2359.43	42941	2359.43	13554
2360.87	42877	2360.87	13590
2362.31	42966	2362.31	13598
2363.74	42720	2363.74	13638
2365.18	42915	2365.18	13636
2366.62	42787	2366.62	13698
2368.05	42935	2368.05	13752
2369.49	42862	2369.49	13732
2370.92	42959	2370.92	13690
2372.36	42816	2372.36	13785
2373.79	42704	2373.79	13759
2375.23	43011	2375.23	13768
2376.66	42901	2376.66	13897
2378.1	42888	2378.1	13695
2379.53	42944	2379.53	13793
2380.96	42882	2380.96	13899
2382.4	43012	2382.4	14052
2383.83	42682	2383.83	14032
2385.26	42974	2385.26	14032
2386.69	42910	2386.69	14049
2388.13	43002	2388.13	14090
2389.56	42712	2389.56	14108
2390.99	42966	2390.99	14181
2392.42	42913	2392.42	14209
2393.85	42906	2393.85	14209
2395.28	43334	2395.28	14199
2396.72	43052	2396.72	14285
2398.14	43188	2398.14	14300
2399.58	43222	2399.58	14341
2401.01	43161	2401.01	14549
2402.43	42906	2402.43	14441

2403.86	43089	2403.86	14449
2405.29	43141	2405.29	14494
2406.72	43078	2406.72	14529
2408.15	43227	2408.15	14604
2409.58	43223	2409.58	14615
2411.01	43256	2411.01	14746
2412.43	43200	2412.43	14707
2413.86	43318	2413.86	14854
2415.29	43408	2415.29	14857
2416.72	43326	2416.72	14944
2418.14	43378	2418.14	14895
2419.57	43476	2419.57	15108
2421	43333	2421	14960
2422.42	43513	2422.42	15125
2423.85	43610	2423.85	15113
2425.27	43581	2425.27	15198
2426.7	43446	2426.7	15403
2428.13	43518	2428.13	15312
2429.55	43574	2429.55	15438
2430.97	43758	2430.97	15409
2432.4	43448	2432.4	15396
2433.82	43586	2433.82	15642
2435.25	43511	2435.25	15726
2436.67	43563	2436.67	15778
2438.09	43670	2438.09	15671
2439.52	43744	2439.52	15867
2440.94	43617	2440.94	15887
2442.36	43763	2442.36	15977
2443.79	43476	2443.79	16236
2445.21	43776	2445.21	16215
2446.63	43884	2446.63	16340
2448.05	43965	2448.05	16500
2449.47	43962	2449.47	16566
2450.89	43925	2450.89	16727
2452.31	43882	2452.31	16863
2453.73	43987	2453.73	16942

2455.16	44130	2455.16	17251
2456.58	43813	2456.58	17437
2458	44024	2458	17544
2459.41	44103	2459.41	17776
2460.83	43795	2460.83	17845
2462.25	44113	2462.25	17840
2463.67	44079	2463.67	17823
2465.09	44192	2465.09	17909
2466.51	44222	2466.51	17737
2467.93	44331	2467.93	17650
2469.34	44218	2469.34	17497
2470.76	44074	2470.76	17569
2472.18	44164	2472.18	17508
2473.59	44339	2473.59	17362
2475.01	44264	2475.01	17259
2476.43	44331	2476.43	17332
2477.84	44467	2477.84	17127
2479.26	44460	2479.26	16937
2480.68	44295	2480.68	16827
2482.09	44324	2482.09	16861
2483.51	44281	2483.51	16778
2484.92	44377	2484.92	16762
2486.34	44368	2486.34	16656
2487.75	44292	2487.75	16684
2489.16	44445	2489.16	16666
2490.58	44299	2490.58	16636
2491.99	44384	2491.99	16591
2493.41	44628	2493.41	16645
2494.82	44569	2494.82	16515
2496.23	44603	2496.23	16423
2497.65	44528	2497.65	16442
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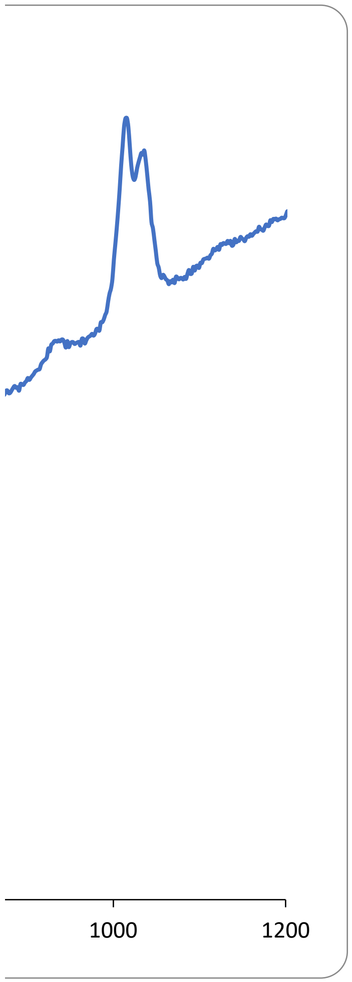
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Raman spectra for inclusions in sample NL247-2

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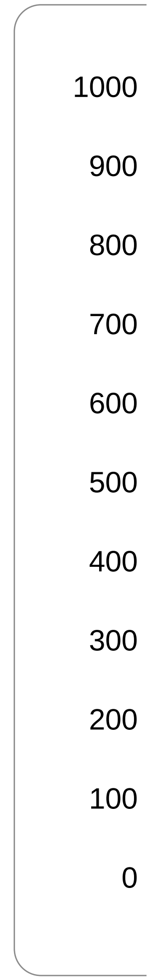

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3412	1640	1328	1215	3412	228
3413	1640	1328	1218	3413	227
3414	1630	1330	1217	3414	228
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3423	1620	1326	1209	3423	225
3424	1620	1325	1212	3424	225
3425	1620	1326	1213	3425	223
3426	1620	1326	1214	3426	222
3427	1610	1321	1214	3427	223
3428	1610	1316	1213	3428	225
3429	1620	1319	1213	3429	225
3430	1620	1322	1213	3430	224
3431	1620	1322	1214	3431	223
3432	1620	1321	1213	3432	222
3433	1620	1320	1208	3433	222
3434	1620	1320	1207	3434	222
3435	1620	1319	1211	3435	222
3436	1620	1320	1209	3436	223
3437	1620	1321	1203	3437	224
3437	1610	1319	1201	3437	223
3438	1610	1315	1204	3438	221
3439	1610	1314	1207	3439	219
3440	1610	1314	1209	3440	218
3441	1600	1312	1207	3441	218
3442	1600	1311	1204	3442	219
3443	1600	1311	1204	3443	220
3444	1600	1310	1203	3444	220
3445	1600	1308	1201	3445	220
3446	1600	1308	1201	3446	220
3447	1600	1310	1202	3447	220
3448	1600	1311	1202	3448	220
3449	1600	1310	1202	3449	220
3450	1600	1309	1201	3450	219

3451	1600	1309	1202	3451	218
3452	1600	1306	1205	3452	217
3453	1600	1302	1209	3453	216
3454	1590	1303	1208	3454	216
3455	1590	1304	1204	3455	216
3456	1590	1300	1201	3456	217
3457	1590	1298	1198	3457	218
3458	1580	1299	1197	3458	218
3459	1580	1300	1197	3459	218
3460	1580	1300	1197	3460	217
3461	1580	1300	1197	3461	216
3462	1580	1300	1197	3462	214
3463	1590	1301	1197	3463	214
3464	1590	1304	1197	3464	214
3464	1590	1301	1197	3464	214
3465	1580	1296	1197	3465	214
3466	1580	1293	1199	3466	215
3467	1580	1293	1200	3467	216
3468	1580	1292	1200	3468	213
3469	1580	1290	1198	3469	211
3470	1580	1286	1193	3470	213
3471	1580	1283	1190	3471	214
3472	1580	1288	1193	3472	214
3473	1580	1290	1196	3473	214
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3475	1570	1290	1195	3475	212
3476	1570	1292	1192	3476	212
3477	1570	1290	1194	3477	212
3478	1570	1288	1196	3478	211
3479	1570	1288	1193	3479	210
3480	1560	1290	1188	3480	210
3481	1570	1289	1190	3481	210
3482	1580	1287	1193	3482	210
3483	1580	1289	1190	3483	211
3484	1570	1287	1186	3484	213
3485	1570	1283	1185	3485	213
3486	1560	1280	1185	3486	213
3487	1560	1278	1185	3487	212
3488	1560	1275	1184	3488	210
3489	1560	1271	1182	3489	208
3490	1560	1271	1181	3490	207
3491	1560	1273	1182	3491	209
3491	1560	1268	1180	3491	209
3492	1560	1263	1177	3492	209
3493	1560	1265	1172	3493	208
3494	1550	1268	1170	3494	207
3495	1560	1266	1174	3495	208
3496	1560	1265	1178	3496	208
3497	1550	1270	1178	3497	208

3498	1550	1274	1179	3498	208
3499	1550	1276	1182	3499	207
3500	1550	1274	1180	3500	206
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		1241	1156		
		1240	1152		
		1240	1149		
		1243	1149		
		1243	1150		

1238	1149
1236	1150
1237	1152
1237	1153
1237	1153
1238	1150
1239	1145
1235	1145
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1231	1147
1230	1148
1228	1146
1226	1144
1229	1143
1231	1144
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1230	1142
1228	1138
1223	1137
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1224	1140
1225	1140
1223	1139
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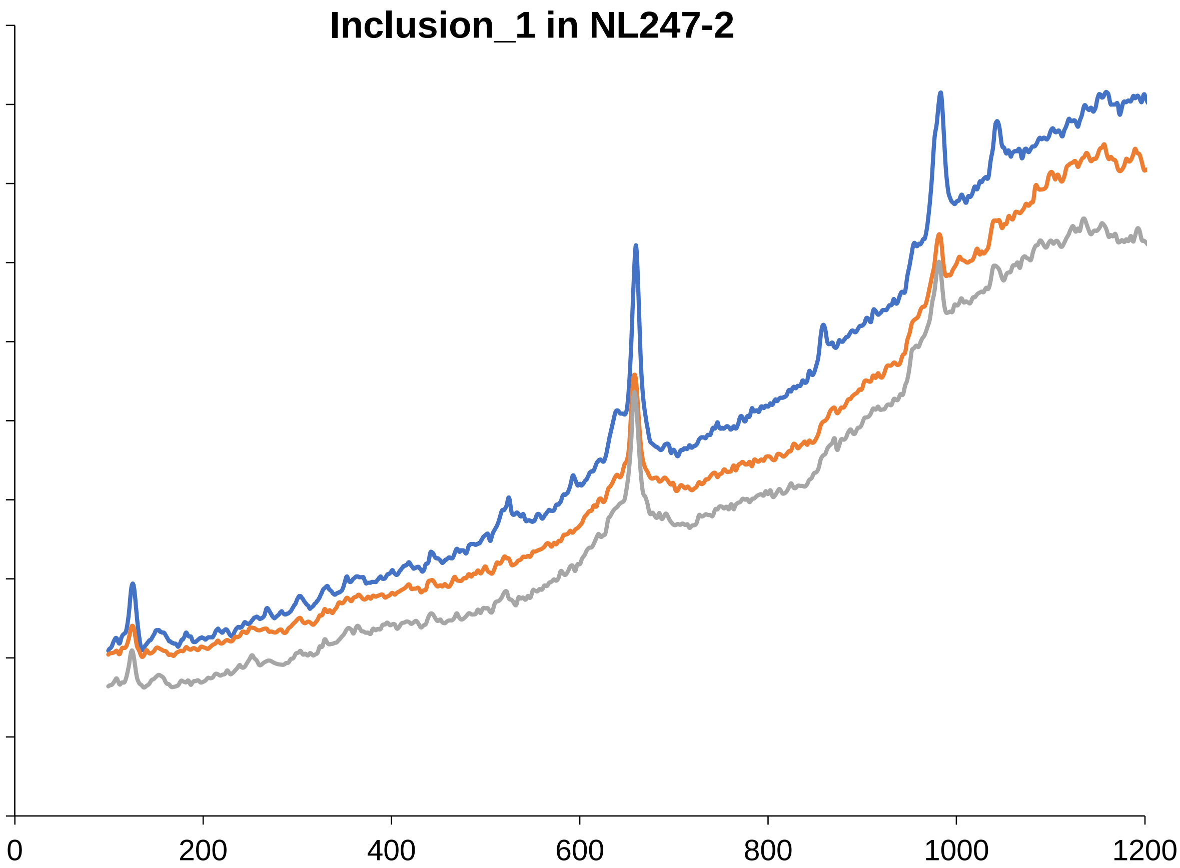
1214	1131
1216	1134



Inclusion_1 in NL247-2
0
200
400
600
800
1000
1200

Trace element abundances for blue diamonds in solution in ppt; <LOD indicates below limit of detection (blank + 3σ), and red font inc

	NL247-2	err	NL247-5	err	NL247-6	err	NL247-12	err	NL247-13	err	NL247-14
Cs	<LOD	<LOD	4.71	0.26	5.96	0.22	2.03	0.21	5.12	0.26	3.69
Rb	<LOD	<LOD	4.54	1.54	1.20	1.52	<LOD	<LOD	<LOD	<LOD	<LOD
Pb	0.69	0.96	1.06	0.23	1.71	0.24	1.97	0.29	0.60	0.22	1.45
Ba	6.10	9.18	17.95	0.93	11.44	0.75	20.05	1.45	4.32	0.15	18.40
Th	0.01	0.10	0.43	0.09	0.05	0.15	0.01	0.07	0.19	0.09	0.15
U	0.05	0.07	0.05	0.02	0.16	0.05	0.26	0.82	0.07	0.02	0.10
Nb	<LOD	<LOD	0.13	0.27	0.55	0.29	0.36	0.28	1.00	0.47	0.16
K	<LOD	<LOD	2963	4126	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	820
La	0.164	0.827	2.549	0.397	0.194	0.375	0.000	0.000	0.265	0.380	0.479
Ce	<LOD	<LOD	16.561	1.243	1.010	0.885	0.118	0.939	0.669	0.883	0.393
Pr	0.026	0.062	0.158	0.029	0.026	0.010	0.022	0.012	0.124	0.045	0.385
Sr	0.470	12.924	1.384	8.944	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	43.627
Nd	0.090	0.167	0.750	0.261	0.109	0.086	0.062	0.067	0.689	0.152	1.919
Sm	0.029	0.050	0.116	0.079	0.023	0.036	0.025	0.025	0.249	0.115	0.105
Hf	<LOD	<LOD	0.683	0.320	0.665	0.243	0.138	0.211	0.206	0.210	0.127
Eu	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Tb	0.003	0.007	0.023	0.008	0.005	0.012	<LOD	<LOD	0.037	0.012	0.008
Dy	0.021	0.024	0.130	0.068	<LOD	<LOD	0.013	0.013	0.238	0.062	0.152
Ho	0.004	0.010	0.029	0.017	0.003	0.004	0.003	0.007	0.068	0.019	0.010
Er	<LOD	<LOD	0.063	0.036	0.013	0.013	0.020	0.020	0.193	0.069	0.027
Yb	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Lu	0.003	0.006	0.011	0.013	<LOD	<LOD	<LOD	<LOD	0.030	0.014	<LOD
Zr	1.99	8.97	27.31	5.35	20.80	7.38	<LOD	<LOD	6.05	5.06	5.69
V	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Sc	<LOD	<LOD	<LOD	<LOD	132.55	5.38	50.68	3.54	<LOD	<LOD	<LOD
Zn	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	5569.24
Cu	45.30	57.29	67.33	14.34	158.84	33.97	<LOD	<LOD	42.45	9.53	86.17
Ti	0.00	0.00	224.48	22.20	523.83	296.39	<LOD	<LOD	2702.51	505.83	181.17
Mn	1.62	5.72	11.73	2.03	2.60	1.93	<LOD	<LOD	2.42	1.94	9.90
Fe	55	193	294	114	177	114	<LOD	<LOD	708	118	467
Co	<LOD	<LOD	1.92	0.47	0.30	0.31	<LOD	<LOD	3.97	0.67	3.52

Mg	<LOD	<LOD	4824.26	238.98	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Ni	6.84	2.96	11.82	0.66	12.51	1.31	<LOD	<LOD	151.60	6.92	17.07
Cr	0.19	9.56	52.75	7.51	24.48	7.07	<LOD	<LOD	10.69	6.81	107.29

dicates below limit of quantification (blank +7σ).

err	Blue1	err	Blue2	err	AB	err	LOD (3σ)	LOD (7σ)
0.19	3.36	0.23	0.78	0.09	0.10	0.04	0.037	0.070
<LOD	0.66	1.52	1.29	1.52	5.93	1.83	0.271	0.478
0.23	4.05	0.32	1.59	0.25	4.02	0.50	0.073	0.154
0.79	7.25	0.45	8.22	0.66	56.83	2.77	0.005	0.010
0.07	0.06	0.07	0.15	0.07	0.04	0.07	0.003	0.006
0.03	0.11	0.09	0.04	0.02	0.12	0.02	0.015	0.029
0.29	2.04	0.29	0.04	0.26	3.33	0.79	0.015	0.029
4121	<LOD	<LOD	564	4135	18152	4296	93	130
0.373	3.058	0.471	0.405	0.371	0.368	0.377	0.000	0.000
0.889	37.230	2.023	2.321	0.893	0.448	0.883	0.025	0.049
0.039	0.069	0.023	0.039	0.022	0.048	0.014	0.003	0.005
9.249	<LOD	<LOD	<LOD	<LOD	0.449	8.971	0.085	0.169
0.393	0.391	0.083	0.157	0.158	0.180	0.079	0.015	0.029
0.139	0.037	0.072	0.042	0.046	0.025	0.014	0.013	0.026
0.209	0.647	0.220	0.132	0.217	0.400	0.210	0.051	0.100
<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.025	0.051
0.006	0.007	0.007	0.002	0.003	0.045	0.014	0.001	0.002
0.073	0.033	0.027	0.019	0.012	0.060	0.027	0.010	0.020
0.008	0.006	0.009	0.007	0.009	0.016	0.011	0.001	0.003
0.027	0.028	0.022	<LOD	<LOD	0.051	0.050	0.027	0.054
<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.001	0.001
<LOD	<LOD	<LOD	0.004	0.004	0.034	0.011	0.002	0.005
5.18	18.20	5.21	4.45	5.06	13.71	5.39	0.268	0.532
<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	1.178	2.307
<LOD	23.53	3.39	<LOD	<LOD	<LOD	<LOD	0.513	1.078
2246.47	<LOD	<LOD	7436.06	2428.38	460845.07	82897.12	224	289
16.81	3157.41	577.70	32.84	8.31	1118.55	205.22	0.521	1.310
220.11	8147.22	635.80	178.92	47.23	281.11	150.80	0.637	1.274
1.98	18.46	2.48	9.52	2.37	6.06	2.01	0.318	0.657
117	450	116	864	127	857	122	8.473	17.343
0.67	5.90	0.57	5.25	0.54	244.95	12.77	0.242	0.458

<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	4513	7338
1.45	17.16	1.16	36.24	2.21	47.61	3.62	0.544	1.076
8.59	23.32	12.14	8.82	6.85	640.64	29.92	0.115	0.230

Trace element abundances for blue diamonds in ppb; <LOD indicates below limit of detection (blank

	NL247-2	err	NL247-5	err	NL247-6	err	NL247-12	err
Cs	<LOD	<LOD	9.03	0.50	1.65	0.06	0.72	0.08
Rb	<LOD	<LOD	8.70	2.95	0.33	0.42	<LOD	<LOD
Pb	0.26	0.37	2.03	0.45	0.47	0.07	0.70	0.10
Ba	2.32	3.49	34.44	1.78	3.17	0.21	7.11	0.52
Th	0.00	0.04	0.83	0.18	0.01	0.04	0.01	0.03
U	0.02	0.03	0.10	0.04	0.04	0.01	0.09	0.29
Nb	<LOD	<LOD	0.25	0.51	0.15	0.08	0.13	0.10
K	<LOD	<LOD	5682	7913	<LOD	<LOD	<LOD	<LOD
La	0.062	0.315	4.889	0.761	0.054	0.104	<LOD	<LOD
Ce	<LOD	<LOD	31.763	2.383	0.280	0.245	0.042	0.333
Pr	0.010	0.024	0.303	0.056	0.007	0.003	0.008	0.004
Sr	0.179	4.920	2.654	17.154	<LOD	<LOD	<LOD	<LOD
Nd	0.034	0.064	1.439	0.500	0.030	0.024	0.022	0.024
Sm	0.011	0.019	0.222	0.151	0.006	0.010	0.009	0.009
Hf	<LOD	<LOD	1.311	0.614	0.184	0.067	0.049	0.075
Eu	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Tb	0.001	0.003	0.045	0.016	0.001	0.003	<LOD	<LOD
Dy	0.008	0.009	0.249	0.130	<LOD	<LOD	0.005	0.005
Ho	0.002	0.004	0.055	0.033	0.001	0.001	0.001	0.003
Er	<LOD	<LOD	0.121	0.068	0.004	0.004	0.007	0.007
Yb	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Lu	0.001	0.002	0.021	0.026	<LOD	<LOD	<LOD	<LOD
Zr	0.76	3.41	52.37	10.25	5.76	2.05	0.00	0.00
V	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Sc	<LOD	<LOD	<LOD	<LOD	36.74	1.49	17.98	1.26
Zn	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Cu	17.24	21.81	129.14	27.50	44.02	9.41	<LOD	<LOD
Ti	<LOD	<LOD	431	43	145	82	<LOD	<LOD
Mn	0.62	2.18	22.50	3.89	0.72	0.54	<LOD	<LOD
Fe	20.9	73.4	563.6	219.3	49.1	31.6	<LOD	<LOD
Co	<LOD	<LOD	3.68	0.90	0.08	0.09	<LOD	<LOD
Mg	<LOD	<LOD	9252.50	458.35	<LOD	<LOD	<LOD	<LOD
Ni	2.60	1.13	22.66	1.27	3.47	0.36	<LOD	<LOD
Cr	0.07	3.64	101.17	14.40	6.78	1.96	<LOD	<LOD
weight (mg)	2.627		0.521		3.608		2.819	

Zr/Hf	#VALUE!	39.963	31.295	0.000
Ti/Eu	#VALUE!			

+ 3σ), and red font indicates below limit of quantification (blank +7σ).

NL247-13	err	NL247-14	err	Blue1	err	Blue2	err	AB
2.25	0.11	3.27	0.17	1.32	0.09	0.71	0.09	0.02
<LOD	<LOD	<LOD	<LOD	0.26	0.60	1.18	1.39	1.39
0.26	0.10	1.29	0.21	1.59	0.13	1.45	0.23	0.95
1.90	0.06	16.34	0.70	2.85	0.18	7.53	0.61	13.36
0.08	0.04	0.13	0.06	0.02	0.03	0.13	0.06	0.01
0.03	0.01	0.09	0.02	0.04	0.03	0.03	0.02	0.03
0.44	0.21	0.14	0.25	0.80	0.11	0.04	0.24	0.78
<LOD	<LOD	728	3658	<LOD	<LOD	517	3787	4267
0.117	0.167	0.425	0.331	1.201	0.185	0.371	0.340	0.087
0.294	0.388	0.349	0.789	14.617	0.794	2.126	0.818	0.105
0.054	0.020	0.341	0.034	0.027	0.009	0.035	0.020	0.011
<LOD	<LOD	38.735	8.211	<LOD	<LOD	<LOD	<LOD	0.106
0.303	0.067	1.704	0.349	0.154	0.033	0.143	0.145	0.042
0.109	0.051	0.093	0.123	0.014	0.028	0.039	0.042	0.006
0.091	0.092	0.113	0.186	0.254	0.087	0.121	0.198	0.094
<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
0.016	0.005	0.007	0.005	0.003	0.003	0.002	0.002	0.011
0.105	0.027	0.135	0.065	0.013	0.011	0.018	0.011	0.014
0.030	0.008	0.009	0.007	0.003	0.003	0.006	0.008	0.004
0.085	0.030	0.024	0.024	0.011	0.008	<LOD	<LOD	0.012
<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
0.013	0.006	<LOD	<LOD	<LOD	<LOD	0.003	0.003	0.008
2.66	2.22	5.05	4.60	7.15	2.04	4.07	4.64	3.22
<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
<LOD	<LOD	<LOD	<LOD	9.24	1.33	<LOD	<LOD	<LOD
<LOD	<LOD	4945	1995	<LOD	<LOD	6811	2224	108337
18.66	4.19	76.50	14.93	1239.59	226.80	30.08	7.61	262.95
1188	222	161	195	3199	250	164	43	66
1.06	0.85	8.79	1.76	7.25	0.97	8.72	2.17	1.43
311.4	51.8	414.3	103.6	176.7	45.5	791.5	116.6	201.4
1.75	0.30	3.13	0.59	2.32	0.23	4.81	0.49	57.58
<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
66.63	3.04	15.15	1.28	6.74	0.45	33.19	2.03	11.19
4.70	2.99	95.26	7.63	9.15	4.76	8.08	6.28	150.60
2.275		1.126		2.547		1.092		4.254
29.361		44.715		28.145		33.691		34.311

err
0.01
0.43
0.12
0.65
0.02
0.01
0.19
1010
0.089
0.208
0.003
2.109
0.018
0.003
0.049
<LOD
0.003
0.006
0.003
0.012
<LOD
0.003
1.27
<LOD
<LOD
19488
48.24
35
0.47
28.8
3.00
<LOD
0.85
7.03

Carbon isotopes, nitrogen concentration, and boron concentration of blue diamonds. Multiple spots were analysed on each diamond. Nit

Diamond	Spot Name	13C/12C	$\delta^{13}C_{VPDB}$	2σ (‰) inter-session	N (ppm)	2σ (ppm)	B (ug/g)	1σ (ppm)
NL247-2	S5649@1	0.01101	-15.50	0.15	<0.35		0.014	0.002
NL247-2	S5649@2	0.01101	-15.58	0.13	<0.35		0.015	0.002
NL247-2	S5649@3	0.01100	-15.74	0.14	<0.35		0.253	0.006
NL247-2	S5649@4	0.01101	-15.60	0.13	<0.35		0.013	0.001
NL247-2	S5649@5	0.01101	-15.65	0.14	<0.35		0.013	0.001
NL247-2	S5649@6	0.01101	-15.56	0.15	<0.35		0.018	0.002
NL247-2	S5649@7	0.01101	-15.58	0.15	<0.35		0.019	0.002
NL247-2	S5649@8	0.01101	-15.54	0.14	<0.35		0.015	0.002
NL247-2	S5649@9	0.01100	-15.66	0.16	<0.35		0.246	0.006
NL247-2	S5649@10	0.01100	-15.73	0.15			0.251	0.006
NL247-2	S5649@11	0.01101	-15.61	0.13	<0.35			
NL247-2	S5649@12	0.01101	-15.60	0.14			0.243	0.006
NL247-2	S5649@13				<0.35			
NL247-2	S5649@14	0.01100	-15.71	0.16			0.236	0.006
NL247-2	S5649@15				<0.35			
average			-15.62	0.16	<0.35		0.111	0.003
2σ			0.15				0.238	
NL247-3	S5650@1	0.01099	-16.77	0.13	<0.35		0.159	0.005
NL247-3	S5650@2	0.01099	-16.90	0.15			0.199	0.005
NL247-3	S5650@3	0.01099	-16.90	0.15	<0.35		0.228	0.007
NL247-3	S5650@4							
NL247-3	S5650@5				<0.35			
NL247-3	S5650@6	0.01099	-16.98	0.13			0.150	0.004
NL247-3	S5650@7				<0.35			
NL247-3	S5650@8	0.01099	-16.90	0.17			0.182	0.006
NL247-3	S5650@9	0.01099	-16.96	0.14	<0.35		0.188	0.006
NL247-3	S5650@10							
NL247-3	S5650@11	0.01099	-16.88	0.13	<0.35		0.118	0.004
NL247-3	S5650@12							
average			-16.90	0.17	<0.35		0.175	0.006
2σ			0.14				0.072	

NL247-4	S5651@1	0.01099	-16.85	0.13	<0.5	0.211	0.007
NL247-4	S5651@2	0.01099	-16.94	0.13	<0.5	0.191	0.006
NL247-4	S5651@3	0.01099	-16.77	0.14	<0.5	0.156	0.005
NL247-4	S5651@4	0.01099	-16.86	0.12	<0.5	0.197	0.007
NL247-4	S5651@5	0.01099	-16.83	0.13	<0.5	0.210	0.006
NL247-4	S5651@6	0.01099	-16.84	0.15	<0.5	0.156	0.005
NL247-4	S5651@7	0.01099	-16.85	0.13	<0.5	0.173	0.007
NL247-4	S5651@8	0.01099	-16.82	0.13	<0.5	0.190	0.006
NL247-4	S5651@9	0.01099	-16.85	0.14	<0.5	0.228	0.008
NL247-4	S5651@10	0.01099	-16.78	0.12	<0.5	0.204	0.006
NL247-4	S5651@11	0.01099	-16.80	0.13	<0.5	0.208	0.006
NL247-4	S5651@12	0.01099	-16.77	0.12	<0.5	0.204	0.006
NL247-4	S5651@13	0.01099	-16.81	0.14	<0.5	0.172	0.006
NL247-4	S5651@14	0.01099	-16.90	0.13	<0.5	0.195	0.006
average			-16.83	0.15	<0.5	0.193	0.006
2σ			0.09			0.042	
NL247-5	S5652@1	0.01099	-16.75	0.14	<0.5	0.019	0.002
NL247-5	S5652@2	0.01099	-16.79	0.14	<0.5	0.014	0.002
NL247-5	S5652@3	0.01099	-16.75	0.12	<0.5	0.015	0.002
NL247-5	S5652@4	0.01099	-16.82	0.12	<0.5	0.017	0.002
NL247-5	S5652@5	0.01099	-16.81	0.15	<0.5	0.013	0.002
NL247-5	S5652@6	0.01099	-16.72	0.17	<0.5	0.015	0.002
NL247-5	S5652@7	0.01099	-16.66	0.13	<0.5	0.015	0.002
NL247-5	S5652@8	0.01099	-16.74	0.13	<0.5	0.013	0.002
NL247-5	S5652@9	0.01099	-16.82	0.12	<0.5	0.199	0.006
NL247-5	S5652@10	0.01099	-16.78	0.16	<0.5	0.013	0.001
NL247-5	S5652@11	0.01099	-16.65	0.12	<0.5	0.017	0.002
NL247-5	S5652@12	0.01099	-16.72	0.15	<0.5	0.015	0.002
NL247-5	S5652@13	0.01099	-16.87	0.14	<0.5	0.240	0.006
NL247-5	S5652@14	0.01099	-16.69	0.17	<0.5	0.013	0.001
NL247-5	S5652@15	0.01099	-16.83	0.13	<0.5	0.208	0.008
average			-16.76	0.17	<0.5	0.055	0.003
2σ			0.13			0.167	
NL247-6	S5653@1	0.01099	-16.58	0.13	<0.5	0.015	0.002

NL247-6	S5653@2	0.01099	-16.72	0.13	<0.5		0.015	0.002
NL247-6	S5653@3	0.01099	-16.62	0.15	<0.5		0.013	0.002
NL247-6	S5653@4	0.01099	-16.64	0.15	<0.5		0.016	0.002
NL247-6	S5653@5	0.01099	-16.66	0.16	<0.5		0.016	0.002
NL247-6	S5653@6	0.01099	-16.72	0.15	<0.5		0.032	0.002
NL247-6	S5653@7	0.01099	-16.76	0.14	<0.5		0.033	0.003
NL247-6	S5653@8	0.01099	-16.69	0.18	<0.5		0.036	0.003
NL247-6	S5653@9	0.01099	-16.55	0.15	<0.5		0.011	0.001
NL247-6	S5653@10	0.01099	-16.72	0.13	<0.5		0.203	0.006
NL247-6	S5653@11	0.01099	-16.74	0.16	<0.5		0.030	0.002
NL247-6	S5653@12	0.01099	-16.69	0.18	<0.5		0.015	0.002
NL247-6	S5653@13	0.01099	-16.74	0.15	<0.5		0.030	0.002
average			-16.68	0.18	<0.5		0.045	0.002
2σ			0.13				0.102	
NL247-7	S5654@1	0.01100	-16.47	0.14	<0.5		0.226	0.006
NL247-7	S5654@2	0.01100	-16.37	0.14	<0.5		0.204	0.006
NL247-7	S5654@3	0.01100	-16.54	0.14	<0.5		0.235	0.006
NL247-7	S5654@4	0.01100	-16.50	0.16	<0.5		0.208	0.006
NL247-7	S5654@5	0.01100	-16.49	0.14	<0.5		0.186	0.006
NL247-7	S5654@6	0.01100	-16.36	0.14	<0.5		0.234	0.007
NL247-7	S5654@7	0.01100	-16.47	0.13	<0.5		0.203	0.006
NL247-7	S5654@8	0.01100	-16.52	0.14	<0.5		0.151	0.007
NL247-7	S5654@9	0.01100	-16.45	0.14	<0.5		0.222	0.006
NL247-7	S5654@10	0.01100	-16.52	0.13	<0.5		0.195	0.006
NL247-7	S5654@11	0.01100	-16.52	0.14	<0.5		0.197	0.006
NL247-7	S5654@12	0.01100	-16.47	0.13	<0.5		0.190	0.006
NL247-7	S5654@13	0.01099	-16.63	0.15	<0.5		0.165	0.005
NL247-7	S5654@14	0.01100	-16.48	0.13	<0.5		0.213	0.006
average			-16.49	0.16	<0.5		0.202	0.006
2σ			0.13				0.049	
NL247-8	S5655@1	0.01099	-16.92	0.13	<0.35		0.150	0.004
NL247-8	S5655@2	0.01099	-16.86	0.15			0.198	0.005
NL247-8	S5655@3	0.01099	-16.83	0.16	<0.35		0.172	0.006
NL247-8	S5655@4	0.01099	-16.88	0.15			0.182	0.005

NL247-8	S5655@5	0.01099	-16.94	0.13	<0.35	0.214	0.005
NL247-8	S5655@6	0.01099	-16.79	0.15		0.197	0.007
NL247-8	S5655@7	0.01099	-16.85	0.14	<0.35	0.214	0.007
NL247-8	S5655@8	0.01099	-16.87	0.13		0.185	0.006
NL247-8	S5655@9				<0.35	0.243	0.006
NL247-8	S5655@10						
NL247-8	S5655@11				<0.35		
NL247-8	S5655@12						
NL247-8	S5655@13				<0.35		
NL247-8	S5655@14						
NL247-8	S5655@15				<0.35		
average			-16.87	0.16	<0.35	0.195	0.006
2σ			0.10			0.054	
NL247-9	S5656@1	0.01101	-15.04	0.14	<0.5	0.011	0.002
NL247-9	S5656@2	0.01101	-15.14	0.15	<0.5	0.091	0.004
NL247-9	S5656@3	0.01102	-14.47	0.13	<0.5	0.008	0.001
NL247-9	S5656@4	0.01102	-14.52	0.16	<0.5	0.113	0.005
NL247-9	S5656@5	0.01102	-14.63	0.13	<0.5	0.093	0.004
NL247-9	S5656@6	0.01102	-14.45	0.13	<0.5	0.104	0.005
NL247-9	S5656@7	0.01102	-14.65	0.13	<0.5	0.113	0.004
NL247-9	S5656@8	0.01102	-14.52	0.14	<0.5	0.114	0.004
NL247-9	S5656@9	0.01102	-14.42	0.14	<0.5	0.008	0.001
NL247-9	S5656@10	0.01102	-14.51	0.13	<0.5	0.096	0.004
NL247-9	S5656@11	0.01102	-14.55	0.13	<0.5	0.107	0.006
NL247-9	S5656@12	0.01102	-14.67	0.14	<0.5	0.099	0.004
NL247-9	S5656@13	0.01102	-14.51	0.13	<0.5	0.116	0.004
NL247-9	S5656@14	0.01102	-14.54	0.14	<0.5	0.103	0.005
NL247-9	S5656@15	0.01102	-14.60	0.13	<0.5	0.103	0.004
NL247-9	S5656@16	0.01102	-14.41	0.13	<0.5	0.006	0.001
NL247-9	S5656@17	0.01101	-15.00	0.13	<0.5	0.010	0.002
average			-14.63	0.16	<0.5	0.076	0.004
2σ			0.44			0.091	
NL247-10	S5657A@1	0.01100	-16.49	0.14	<0.5	0.014	0.002
NL247-10	S5657A@2	0.01100	-16.53	0.13	<0.5	0.016	0.002

NL247-10	S5657A@3	0.01100	-16.53	0.14	<0.5	0.199	0.006
NL247-10	S5657A@4	0.01099	-16.60	0.15	<0.5	0.160	0.005
NL247-10	S5657A@5	0.01099	-16.65	0.14	<0.5	0.197	0.006
NL247-10	S5657A@6	0.01100	-16.47	0.13	<0.5	0.142	0.006
NL247-10	S5657A@7	0.01100	-16.49	0.15	<0.5	0.191	0.006
NL247-10	S5657A@8	0.01099	-16.69	0.14	<0.5	0.207	0.006
NL247-10	S5657A@9	0.01099	-16.61	0.14	<0.5	0.177	0.006
NL247-10	S5657A@10	0.01100	-16.53	0.14	<0.5	0.179	0.006
NL247-10	S5657A@11	0.01100	-16.47	0.14	<0.5	0.136	0.006
NL247-10	S5657A@12	0.01100	-16.49	0.15	<0.5	0.123	0.005
NL247-10	S5657A@13	0.01099	-16.67	0.14	<0.5	0.204	0.008
average			-16.55	0.15	<0.5	0.149	0.005
2σ			0.16			0.131	
NL247-11	S5659@1	0.01101	-15.65	0.14	<0.5	0.013	0.001
NL247-11	S5659@2	0.01101	-15.63	0.14	<0.5	0.025	0.002
NL247-11	S5659@3	0.01100	-15.82	0.14	<0.5	0.148	0.007
NL247-11	S5659@4	0.01100	-15.74	0.15	<0.5	0.168	0.006
NL247-11	S5659@5	0.01100	-15.73	0.13	<0.5	0.175	0.006
NL247-11	S5659@6	0.01100	-15.67	0.13	<0.5	0.165	0.008
NL247-11	S5659@7	0.01101	-15.64	0.14	<0.5	0.130	0.006
NL247-11	S5659@8	0.01100	-15.67	0.13	<0.5	0.177	0.006
NL247-11	S5659@9	0.01100	-15.75	0.13	<0.5	0.173	0.006
NL247-11	S5659@10	0.01100	-15.81	0.14	<0.5	0.169	0.007
NL247-11	S5659@11	0.01100	-15.78	0.14	<0.5	0.172	0.007
NL247-11	S5659@12	0.01100	-15.74	0.14	<0.5	0.154	0.007
NL247-11	S5659@13	0.01100	-15.82	0.14	<0.5	0.172	0.006
average			-15.73	0.15	<0.5	0.142	0.006
2σ			0.14			0.112	
NL247-12	S5660@1	0.01101	-15.29	0.15	<0.3		
NL247-12	S5660@2	0.01101	-15.23	0.14			
NL247-12	S5660@3	0.01101	-15.34	0.15	<0.35		
NL247-12	S5660@4	0.01101	-15.33	0.12	<0.35		
NL247-12	S5660@5	0.01101	-15.31	0.12	<0.35		
NL247-12	S5660@6	0.01101	-15.42	0.15			

NL247-12	S5660@7	0.01101	-15.33	0.14	<0.35		
NL247-12	S5660@8	0.01101	-15.44	0.15			
NL247-12	S5660@9	0.01101	-15.32	0.14	<0.35		
NL247-12	S5660@10	0.01101	-15.41	0.12			
NL247-12	S5660@11	0.01101	-15.38	0.13			
NL247-12	S5660@12	0.01101	-15.34	0.13			
NL247-12	S5660@13	0.01101	-15.39	0.14			
NL247-12	S5660@14	0.01101	-15.36	0.12			
NL247-12	S5660@15	0.01101	-15.34	0.12			
NL247-12	S5660@16	0.01101	-15.24	0.13			
average			-15.34	0.15	<0.35		
2σ			0.12				
NL247-13	S5661@1	0.01099	-16.70	0.14	<0.5	0.003	0.001
NL247-13	S5661@2	0.01099	-16.76	0.14	<0.5	0.276	0.007
NL247-13	S5661@3	0.01099	-16.85	0.15	<0.5	0.287	0.008
NL247-13	S5661@4	0.01099	-16.75	0.13	<0.5	0.251	0.007
NL247-13	S5661@5	0.01099	-16.85	0.15	<0.5	0.266	0.008
NL247-13	S5661@6	0.01099	-16.72	0.13	<0.5	0.259	0.009
NL247-13	S5661@7	0.01099	-16.77	0.15	<0.5	0.255	0.007
NL247-13	S5661@8	0.01099	-16.87	0.13	<0.5	0.263	0.007
NL247-13	S5661@9	0.01099	-16.84	0.14	<0.5	0.260	0.009
NL247-13	S5661@10	0.01099	-16.93	0.16	<0.5	0.253	0.008
NL247-13	S5661@11	0.01099	-16.88	0.15	<0.5	0.265	0.007
NL247-13	S5661@12	0.01099	-16.76	0.16	<0.5	0.241	0.007
NL247-13	S5661@13	0.01099	-16.74	0.14	<0.5	0.248	0.007
NL247-13	S5661@14	failed			<0.5		
average			-16.80	0.16	<0.5	0.241	0.007
2σ			0.14			0.145	
NL247-14	S5662@1	0.01100	-15.84	0.16		0.015	0.001
NL247-14	S5662@2	0.01100	-15.77	0.15		0.031	0.002
NL247-14	S5662@3	0.01100	-15.69	0.13		0.020	0.002
NL247-14	S5662@4	0.01100	-15.78	0.13		0.027	0.003
NL247-14	S5662@5	0.01100	-15.80	0.13		0.026	0.002
NL247-14	S5662@6	0.01100	-15.94	0.15		0.239	0.007

NL247-14	S5662@7						
NL247-14	S5662@8						
NL247-14	S5662@9	0.01100	-16.04	0.15		0.272	0.006
NL247-14	S5662@10						
NL247-14	S5662@11	0.01100	-15.74	0.13		0.024	0.002
NL247-14	S5662@12	0.01100	-15.90	0.14		0.275	0.006
NL247-14	S5662@13						
NL247-14	S5662@14	0.01100	-16.00	0.14		0.268	0.007
average			-15.85	0.16	0.00	0.120	0.004
2σ			0.23			0.248	
NL247-15	S5663@1	0.01100	-16.48	0.13	<0.5	0.199	0.006
NL247-15	S5663@2	0.01100	-16.28	0.14	<0.5	0.184	0.009
NL247-15	S5663@3	0.01100	-16.49	0.13	<0.5	0.132	0.005
NL247-15	S5663@4	0.01099	-16.57	0.14	<0.5	0.180	0.007
NL247-15	S5663@5	failed			<0.5	0.230	0.007
NL247-15	S5663@6	0.01099	-16.60	0.14	<0.5	0.166	0.006
NL247-15	S5663@7	0.01099	-16.74	0.15	<0.5	0.211	0.006
NL247-15	S5663@8	0.01099	-16.71	0.13	<0.5	0.182	0.007
NL247-15	S5663@9	0.01099	-16.75	0.13	<0.5	0.124	0.005
NL247-15	S5663@10	0.01099	-16.56	0.13	<0.5	0.012	0.002
NL247-15	S5663@11	0.01099	-16.65	0.15	<0.5	0.017	0.002
NL247-15	S5663@12	0.01099	-16.61	0.13	<0.5	0.017	0.002
NL247-15	S5663@13	0.01099	-16.58	0.14	<0.5	0.016	0.002
NL247-15	S5663@14	0.01099	-16.75	0.13	<0.5	0.200	0.008
average			-16.60	0.15	<0.5	0.134	0.005
2σ			0.27			0.165	
NL247-16	S5664@1	0.01099	-16.64	0.15		0.021	0.002
NL247-16	S5664@2						
NL247-16	S5664@3						
NL247-16	S5664@4						
NL247-16	S5664@5						
NL247-16	S5664@6	0.01099	-16.87	0.14		0.024	0.002
NL247-16	S5664@7	0.01099	-16.79	0.14		0.028	0.003
NL247-16	S5664@8	0.01099	-16.77	0.16		0.017	0.001

NL247-16	S5664@9	0.01099	-16.73	0.17		0.045	0.002
NL247-16	S5664@10	0.01099	-16.90	0.14		0.259	0.007
NL247-16	S5664@11	0.01099	-16.72	0.14		0.271	0.006
NL247-16	S5664@12						
NL247-16	S5664@13						
NL247-16	S5664@14	0.01099	-16.94	0.13		0.269	0.006
NL247-16	S5664@15	0.01099	-16.96	0.14		0.293	0.009
NL247-16	S5664@16						
average			-16.81	0.17	0.00	0.136	0.004
2σ			0.22			0.260	
NL247-17	S5665@1	0.01099	-16.83	0.14	<0.35	0.126	0.005
NL247-17	S5665@2	0.01099	-16.81	0.13		0.169	0.005
NL247-17	S5665@3	0.01099	-16.81	0.15	<0.35	0.214	0.005
NL247-17	S5665@4	0.01099	-16.83	0.13	<0.35	0.014	0.001
NL247-17	S5665@5	0.01099	-16.74	0.15	<0.35	0.012	0.001
NL247-17	S5665@6	0.01099	-16.75	0.15	<0.35	0.014	0.001
NL247-17	S5665@7	0.01099	-16.91	0.13	<0.35	0.183	0.005
NL247-17	S5665@8	0.01099	-16.85	0.14		0.188	0.005
NL247-17	S5665@9	0.01099	-16.93	0.13	<0.35	0.223	0.005
NL247-17	S5665@10	0.01099	-16.81	0.14		0.012	0.002
NL247-17	S5665@11	0.01099	-16.76	0.17	<0.35	0.013	0.001
NL247-17	S5665@12	0.01099	-17.07	0.13		0.034	0.002
NL247-17	S5665@13	0.01099	-17.15	0.13	<0.35	0.030	0.002
average			-16.87	0.17	<0.35	0.095	0.003
2σ			0.24			0.178	
NL247-18	S5666@2	0.01100	-16.45	0.16			
NL247-18	S5666@3	0.01100	-16.40	0.13			
NL247-18	S5666@4	0.01100	-16.46	0.14			
NL247-18	S5666@5	0.01100	-16.43	0.13			
NL247-18	S5666@6	0.01100	-16.24	0.13			
NL247-18	S5666@7	0.01100	-16.44	0.15			
NL247-18	S5666@8	0.01100	-16.40	0.13			
NL247-18	S5666@9	0.01100	-16.31	0.13			
NL247-18	S5666@10	0.01100	-16.43	0.14			

NL247-18	S5666@11	0.01100	-16.28	0.12			
average			-16.38	0.16	0.00		
2σ			0.16				
NL247-19	S5667@1	0.01100	-16.50	0.14	<0.5	0.217	0.006
NL247-19	S5667@2	0.01100	-16.49	0.16	<0.5	0.247	0.007
NL247-19	S5667@3	0.01100	-16.47	0.13	<0.5	0.232	0.009
NL247-19	S5667@4	0.01100	-16.54	0.16	<0.5	0.238	0.009
NL247-19	S5667@5	0.01100	-16.40	0.13	<0.5	0.019	0.002
NL247-19	S5667@6	0.01100	-16.39	0.13	<0.5	0.251	0.007
NL247-19	S5667@7	0.01100	-16.43	0.14	<0.5	0.197	0.006
NL247-19	S5667@8	0.01099	-16.56	0.13	<0.5	0.249	0.007
NL247-19	S5667@9	0.01100	-16.47	0.16	<0.5	0.257	0.007
NL247-19	S5667@10	0.01100	-16.36	0.15	<0.5	0.015	0.002
NL247-19	S5667@11	0.01099	-16.56	0.13	<0.5	0.221	0.006
NL247-19	S5667@12	0.01100	-16.38	0.14	<0.5	0.237	0.006
NL247-19	S5667@13	0.01099	-16.60	0.13	<0.5	0.225	0.007
average			-16.47	0.16	<0.5	0.201	0.006
2σ			0.16			0.166	
NL247-20	S5668@1	0.01100	-15.70	0.13	<0.5	0.180	0.005
NL247-20	S5668@2	0.01100	-15.71	0.13	<0.5	0.184	0.006
NL247-20	S5668@3	0.01101	-15.53	0.15	<0.5	0.185	0.006
NL247-20	S5668@4	0.01101	-15.59	0.13	<0.5	0.181	0.006
NL247-20	S5668@5	0.01101	-15.61	0.14	<0.5	0.185	0.008
NL247-20	S5668@6	0.01100	-15.66	0.14	<0.5	0.192	0.006
NL247-20	S5668@7	0.01100	-15.77	0.15	<0.5	0.185	0.009
NL247-20	S5668@8	0.01100	-15.65	0.14	<0.5	0.182	0.007
NL247-20	S5668@9	0.01101	-15.63	0.15	<0.5	0.192	0.006
NL247-20	S5668@10	0.01100	-15.77	0.13	<0.5	0.186	0.006
NL247-20	S5668@11	0.01100	-15.67	0.15	<0.5	0.180	0.007
NL247-20	S5668@12	0.01100	-15.75	0.16	<0.5	0.179	0.006
NL247-20	S5668@13	0.01100	-15.70	0.13	<0.5	0.190	0.009
NL247-20	S5668@14	0.01100	-15.79	0.14	<0.5	0.186	0.006
average			-15.68	0.16	<0.5	0.185	0.007
2σ			0.15			0.008	

NL247-21	S5669@1	0.01100	-16.47	0.13	<0.5	0.014	0.002
NL247-21	S5669@2	0.01100	-16.45	0.13	<0.5	0.014	0.002
NL247-21	S5669@3	0.01100	-16.44	0.13	<0.5	0.011	0.002
NL247-21	S5669@4	0.01100	-16.49	0.13	<0.5	0.208	0.006
NL247-21	S5669@5	0.01100	-16.49	0.16	<0.5	0.223	0.006
NL247-21	S5669@6	0.01099	-16.65	0.14	<0.5	0.254	0.007
NL247-21	S5669@7	0.01100	-16.54	0.14	<0.5	0.145	0.007
NL247-21	S5669@8	0.01099	-16.59	0.15	<0.5	0.212	0.007
NL247-21	S5669@9	0.01099	-16.57	0.14	<0.5	0.198	0.006
NL247-21	S5669@10	0.01099	-16.63	0.13	<0.5	0.234	0.007
NL247-21	S5669@11	0.01100	-16.51	0.16	<0.5	0.253	0.008
NL247-21	S5669@12	0.01099	-16.55	0.13	<0.5	0.236	0.007
NL247-21	S5669@13	0.01100	-16.52	0.15	<0.5	0.234	0.008
NL247-21	S5669@14	0.01099	-16.61	0.13	<0.5	0.237	0.007
NL247-21	S5669@15	0.01100	-16.53	0.13	<0.5	0.244	0.007
average			-16.54	0.16	<0.5	0.181	0.006
2σ			0.13			0.182	
NL247-22	S5670@1	0.01100	-16.34	0.13			
NL247-22	S5670@2	0.01100	-16.53	0.15			
NL247-22	S5670@3	0.01100	-16.52	0.14			
NL247-22	S5670@4	0.01100	-16.35	0.14			
NL247-22	S5670@5	0.01099	-16.55	0.16			
NL247-22	S5670@6	0.01100	-16.50	0.14			
NL247-22	S5670@7	0.01100	-16.37	0.13			
NL247-22	S5670@8	0.01100	-16.38	0.13			
NL247-22	S5670@9	0.01100	-16.36	0.14			
NL247-22	S5670@10	0.01100	-16.42	0.15			
NL247-22	S5670@11	0.01100	-16.33	0.14			
NL247-22	S5670@12	0.01100	-16.53	0.14			
NL247-22	S5670@13	0.01100	-16.34	0.14			
NL247-22	S5670@14	0.01100	-16.45	0.14			
average			-16.43	0.16	0.00		
2σ			0.17				

NL247-23	S5672@1	0.01113	-4.22	0.15	313.79	10.01	0.001	0.000
NL247-23	S5672@2	0.01113	-4.69	0.14	299.19	9.30	0.000	0.000
NL247-23	S5672@3	0.01113	-4.18	0.15	295.69	9.19	0.001	0.001
NL247-23	S5672@4	0.01112	-5.24	0.15	727.53	22.17		
NL247-23	S5672@5	0.01112	-5.12	0.13	2.80	0.20	0.008	0.001
NL247-23	S5672@6	0.01113	-4.12	0.14	12.85	0.59	0.001	0.000
NL247-23	S5672@7	0.01112	-5.32	0.16	660.54	20.14	0.000	0.000
average			-4.70	0.16	660.54	522.26	0.002	0.000
2σ			1.06				0.006	
Blue 1	S5640B@1	0.01101	-15.15	0.14	<0.35		0.126	0.005
Blue 1	S5640B@2	0.01101	-15.12	0.14			0.144	0.005
Blue 1	S5640B@3	0.01101	-15.12	0.15	<0.35		0.125	0.004
Blue 1	S5640B@4	0.01101	-15.08	0.15			0.120	0.004
Blue 1	S5640B@5	0.01101	-15.02	0.14	<0.35		0.116	0.004
Blue 1	S5640B@6	0.01101	-15.05	0.13			0.132	0.005
Blue 1	S5640B@7	0.01101	-15.08	0.14	<0.35		0.125	0.004
Blue 1	S5640B@8							
Blue 1	S5640B@9				<0.35			
Blue 1	S5640B@10							
Blue 1	S5640B@11				<0.35			
Blue 1	S5640B@12							
average			-15.09	0.15	<0.35		0.127	0.005
2σ			0.09				0.018	
Blue2	S5644A@1	0.01097	-18.61	0.14	<0.35			
Blue2	S5644A@2	0.01097	-18.66	0.15				
Blue2	S5644A@3	0.01097	-18.61	0.14	<0.35			
Blue2	S5644A@4	0.01097	-18.71	0.15				
Blue2	S5644A@5	0.01097	-18.53	0.14	<0.35			
Blue2	S5644A@6	0.01097	-18.69	0.15				
Blue2	S5644A@7	0.01095	-20.53	0.13	<0.35			
Blue2	S5644A@8	0.01095	-20.84	0.14	<0.35			
Blue2	S5644A@9	0.01097	-18.61	0.13				
Blue2	S5644A@10	0.01097	-18.55	0.12				
Blue2	S5644A@11	0.01097	-18.55	0.14	<0.35			

Blue2	S5644A@12	0.01097	-18.56	0.14				
Blue2	S5644A@13	0.01097	-18.63	0.13				
Blue2	S5644A@14	0.01097	-18.65	0.16				
average			-18.91	0.16	<0.35			
2σ			1.51					
AB	S5648@1	0.01095	-20.73	0.15	8.56	0.83	0.498	0.013
AB	S5648@2	0.01095	-20.58	0.14			0.301	0.007
AB	S5648@3	0.01095	-20.63	0.14	9.18	0.44	0.315	0.010
AB	S5648@4	0.01095	-20.61	0.13			0.410	0.010
AB	S5648@5				3.39	0.49		
AB	S5648@6							
AB	S5648@7				2.91	0.49		
AB	S5648@8							
AB	S5648@9	0.01095	-20.42	0.16	0.76	0.10	0.306	0.008
AB	S5648@10	0.01095	-20.50	0.14			0.287	0.007
AB	S5648@11	0.01095	-20.56	0.16	1.41	0.25	0.262	0.007
AB	S5648@12	0.01095	-20.47	0.14			0.279	0.010
AB	S5648@13				1.21	0.14		
AB	S5648@14							
AB	S5648@15				1.69	0.25		
average			-20.56	0.16	3.64	0.37	0.332	0.009
2σ			0.20		3.35		0.161	

trogen concentrations were often below detection limit, which is indicated by the < symbol.

Carbon isotopic data for blue diamonds

Diamond	$\delta^{13}C_{VPDB}$	Reference
Crushed fragment IIB	-14.56	Milledge et al (1983)
Crushed fragment IIB 2	-20.73	Milledge et al (1983)
Fractured fragment IIB	-18.77	Milledge et al (1983)
110208425476	-1.80	Smith et al. (2018)
110208425246	-3.40	Smith et al. (2018)
DVBT	-13.40	Smith et al. (2018)
NL247-2	-15.62	this study
NL247-3	-16.90	this study
NL247-4	-16.83	this study
NL247-5	-16.76	this study
NL247-6	-16.68	this study
NL247-7	-16.49	this study
NL247-8	-16.87	this study
NL247-9	-14.63	this study
NL247-10	-16.55	this study
NL247-11	-15.73	this study
NL247-12	-15.34	this study
NL247-13	-16.80	this study
NL247-14	-15.85	this study
NL247-15	-16.60	this study
NL247-16	-16.81	this study
NL247-17	-16.87	this study
NL247-18	-16.38	this study
NL247-19	-16.47	this study
NL247-20	-15.68	this study
NL247-21	-16.54	this study
NL247-22	-16.43	this study
Blue1	-15.09	this study
Blue2	-18.91	this study
AB	-20.56	this study

Diamond
Crushed fragment IIB
Crushed fragment IIB 2
Fractured fragment IIB
110208425476
110208425246
DVBT
NL247
Blue1
Blue2
AB

$\delta^{13}C_{VPDB}$	Reference
-14.56	Milledge et al (1983)
-20.73	Milledge et al (1983)
-18.77	Milledge et al (1983)
-1.80	Smith et al. (2018)
-3.40	Smith et al. (2018)
-13.40	Smith et al. (2018)
-16.51	this study
-15.09	this study
-18.91	this study
-20.56	this study

Histogram	*Frequency*
-25	0
-24	0
-23	0
-22	0
-21	0
-20	2
-19	0
-18	2
-17	0
-16	15
-15	6
-14	2
-13	1
-12	0
-11	0
-10	0
-9	0
-8	0
-7	0
-6	0
-5	0
-4	0
-3	1
-2	0
-1	1
0	0
1	0
2	0
3	0
4	0
5	0
More	30

Calibration of boron concentration in NL247-20 using hyperspectral CL

Free exciton (FE)	Bound exciton (BE)	BE/FE	B (atoms/cm$^{3)}$	B (atoms/g)	B (mol/g)
1090	320	0.293577982	3.71618E+16	1.05874E+16	1.75812E-08

B (g/g)
1.9007E-07

Carbon isotope database for diamonds of an eclogitic paragenesis

Sample	**$\delta^{13}C_{VPDB}$**	**Reference**
or007	-17.97	Cartigny (1997)
354	-15.97	Cartigny (1997)
or001	-15.89	Cartigny (1997)
or024	-15.86	Cartigny (1997)
or010	-14.25	Cartigny (1997)
or003	-13.08	Cartigny (1997)
454	-10.42	Cartigny (1997)
or011	-10.31	Cartigny (1997)
or023	-9.80	Cartigny (1997)
341	-9.75	Cartigny (1997)
or021	-8.95	Cartigny (1997)
444	-8.91	Cartigny (1997)
541	-8.27	Cartigny (1997)
or053	-7.52	Cartigny (1997)
or012	-6.78	Cartigny (1997)
or009	-6.35	Cartigny (1997)
515	-6.01	Cartigny (1997)
W043	-5.90	Cartigny (1997)
527	-5.73	Cartigny (1997)
U 214	-5.71	Cartigny (1997)
531	-5.70	Cartigny (1997)
333	-5.64	Cartigny (1997)
U 216	-5.54	Cartigny (1997)
343	-5.41	Cartigny (1997)
or019	-5.38	Cartigny (1997)
344	-5.34	Cartigny (1997)
334	-5.27	Cartigny (1997)
or014	-5.25	Cartigny (1997)
540	-5.12	Cartigny (1997)
029	-5.02	Cartigny (1997)
U 218	-4.92	Cartigny (1997)
028	-4.89	Cartigny (1997)
526	-4.85	Cartigny (1997)
361	-4.84	Cartigny (1997)
or025	-4.82	Cartigny (1997)
351	-4.76	Cartigny (1997)
U 210	-4.74	Cartigny (1997)
030	-4.73	Cartigny (1997)
U 211	-4.72	Cartigny (1997)
U 215	-4.70	Cartigny (1997)
031	-4.69	Cartigny (1997)
379	-4.61	Cartigny (1997)
349	-4.50	Cartigny (1997)
537	-4.35	Cartigny (1997)
546	-4.34	Cartigny (1997)
546	-4.34	Cartigny (1997)

346	-4.31	Cartigny (1997)
U 212	-4.23	Cartigny (1997)
U 213	-4.01	Cartigny (1997)
542	-3.99	Cartigny (1997)
514	-3.96	Cartigny (1997)
U 217	-3.95	Cartigny (1997)
U 219	-3.86	Cartigny (1997)
323	-3.62	Cartigny (1997)
or055	-3.39	Cartigny (1997)
342	-10.25	Cartigny (1997), Melton (2013)
538	-5.98	Cartigny (1997), Melton (2013)
538	-5.98	Cartigny (1997), Melton (2013)
348	-5.56	Cartigny (1997), Melton (2013)
547	-5.46	Cartigny (1997), Melton (2013)
539	-5.33	Cartigny (1997), Melton (2013)
539	-5.33	Cartigny (1997), Melton (2013)
545	-5.22	Cartigny (1997), Melton (2013)
545	-5.22	Cartigny (1997), Melton (2013)
544	-5.14	Cartigny (1997), Melton (2013)
414	-5.04	Cartigny (1997), Melton (2013)
338	-5.02	Cartigny (1997), Melton (2013)
468	-4.53	Cartigny (1997), Melton (2013)
468	-4.53	Cartigny (1997), Melton (2013)
455	-4.19	Cartigny (1997), Melton (2013)
513	-3.06	Cartigny (1997), Melton (2013)
513	-3.06	Cartigny (1997), Melton (2013)
G036	-2.12	Cartigny (1997), Melton (2013)
Nam-027	-38.62	Cartigny et al 2004
Nam-056	-29.26	Cartigny et al 2004
Nam-102	-28.70	Cartigny et al 2004
Nam-074	-27.09	Cartigny et al 2004
Nam-114	-26.93	Cartigny et al 2004
Nam-005	-26.63	Cartigny et al 2004
Nam-044	-21.35	Cartigny et al 2004
Nam-043	-16.68	Cartigny et al 2004
Nam-079	-8.08	Cartigny et al 2004
Nam-053	-7.14	Cartigny et al 2004
Nam-041	-6.89	Cartigny et al 2004
Nam-081	-6.66	Cartigny et al 2004
Nam-014	-6.50	Cartigny et al 2004
Nam-063	-6.36	Cartigny et al 2004
Nam-207	-6.33	Cartigny et al 2004
Nam-080	-6.30	Cartigny et al 2004
Nam-022	-5.97	Cartigny et al 2004
Nam-095	-5.96	Cartigny et al 2004
Nam-078	-5.94	Cartigny et al 2004
Nam-216	-5.90	Cartigny et al 2004
Nam-097	-5.84	Cartigny et al 2004
Nam-042	-5.76	Cartigny et al 2004

Nam-202	-5.76	Cartigny et al 2004
Nam-086	-5.69	Cartigny et al 2004
Nam-098	-5.61	Cartigny et al 2004
Nam-208	-5.54	Cartigny et al 2004
Nam-035	-5.37	Cartigny et al 2004
Nam-059	-5.29	Cartigny et al 2004
Nam-021	-5.21	Cartigny et al 2004
Nam-218	-5.14	Cartigny et al 2004
Nam-020	-5.10	Cartigny et al 2004
Nam-047	-5.00	Cartigny et al 2004
Nam-034	-4.91	Cartigny et al 2004
Nam-013	-4.77	Cartigny et al 2004
Nam-026	-4.64	Cartigny et al 2004
Nam-011	-4.42	Cartigny et al 2004
Nam-089	-4.23	Cartigny et al 2004
Nam-205B (2nd diamond)	-4.18	Cartigny et al 2004
Nam-068	-4.11	Cartigny et al 2004
Nam-096	-3.74	Cartigny et al 2004
Nam-038	-3.58	Cartigny et al 2004
Nam-203	-3.46	Cartigny et al 2004
Nam-019	-2.35	Cartigny et al 2004
Nam-080B (2nd Dia?)	-1.63	Cartigny et al 2004
jw-001	-21.13	Cartigny et al. (1998)
jw-021	-19.81	Cartigny et al. (1998)
jw-042	-18.30	Cartigny et al. (1998)
jw-048	-17.39	Cartigny et al. (1998)
jw-002	-15.20	Cartigny et al. (1998)
jw-046	-13.02	Cartigny et al. (1998)
jw-037	-12.81	Cartigny et al. (1998)
jw-013	-12.24	Cartigny et al. (1998)
jw-019	-12.13	Cartigny et al. (1998)
jw-036	-12.10	Cartigny et al. (1998)
jw-004	-12.06	Cartigny et al. (1998)
jw-014	-11.95	Cartigny et al. (1998)
jw-020	-11.22	Cartigny et al. (1998)
jw-026	-10.92	Cartigny et al. (1998)
jw-060	-10.92	Cartigny et al. (1998)
jw-015	-10.83	Cartigny et al. (1998)
jw-028	-10.35	Cartigny et al. (1998)
jw-035	-10.14	Cartigny et al. (1998)
jw-024	-10.06	Cartigny et al. (1998)
jw-051	-9.38	Cartigny et al. (1998)
jw-016	-8.67	Cartigny et al. (1998)
jw-027	-8.67	Cartigny et al. (1998)
jw-057	-8.61	Cartigny et al. (1998)
jw-007	-7.96	Cartigny et al. (1998)
jw-058	-7.79	Cartigny et al. (1998)
jw-006	-7.56	Cartigny et al. (1998)
jw-005	-7.08	Cartigny et al. (1998)

jw-049	-6.67	Cartigny et al. (1998)
jw-050	-6.58	Cartigny et al. (1998)
jw-054	-6.41	Cartigny et al. (1998)
jw-018	-5.76	Cartigny et al. (1998)
jw-010	-5.68	Cartigny et al. (1998)
jw-033	-5.25	Cartigny et al. (1998)
jw-025	-5.22	Cartigny et al. (1998)
jw-003	-5.19	Cartigny et al. (1998)
jw-008	-5.18	Cartigny et al. (1998)
jw-022	-5.04	Cartigny et al. (1998)
jw-053	-4.96	Cartigny et al. (1998)
jw-059	-2.71	Cartigny et al. (1998)
PA-65	-19.40	Cartigny et al. (2009)
PA-63	-11.21	Cartigny et al. (2009)
PA-66	-9.90	Cartigny et al. (2009)
PA-71	-8.36	Cartigny et al. (2009)
PA-73	-5.45	Cartigny et al. (2009)
PA-64	-5.10	Cartigny et al. (2009)
PA-74	-4.37	Cartigny et al. (2009)
j11a-24	-21.07	Deines et al (1991)
j28a-24	-18.29	Deines et al (1991)
k053	-11.81	Deines et al (1991)
k039	-11.44	Deines et al (1991)
k054	-7.82	Deines et al (1991)
k016	-7.77	Deines et al (1991)
k037	-6.57	Deines et al (1991)
k050	-5.33	Deines et al (1991)
k017	-5.13	Deines et al (1991)
k008	-5.11	Deines et al (1991)
k042	-5.09	Deines et al (1991)
k041	-4.92	Deines et al (1991)
k043	-4.70	Deines et al (1991)
k049	-4.59	Deines et al (1991)
k052	-4.48	Deines et al (1991)
j26a-24	-4.47	Deines et al (1991)
k051	-4.33	Deines et al (1991)
k019	-3.94	Deines et al (1991)
k056	-2.78	Deines et al (1991)
k007	-2.42	Deines et al (1991)
k006	-1.80	Deines et al (1991)
rv076	-16.28	Deines et al. (1987)
rv072	-15.73	Deines et al. (1987)
rv068	-15.46	Deines et al. (1987)
rv069	-15.40	Deines et al. (1987)
rv042	-15.39	Deines et al. (1987)
rv045	-15.37	Deines et al. (1987)
rv071	-15.32	Deines et al. (1987)
rv070	-15.14	Deines et al. (1987)
rv073	-15.02	Deines et al. (1987)

rv075	-6.32	Deines et al. (1987)
rv079	-5.80	Deines et al. (1987)
rv077	-5.56	Deines et al. (1987)
p41a	-12.34	Deines et al. (1989)
f84	-7.86	Deines et al. (1989)
f67	-7.67	Deines et al. (1989)
f91	-6.29	Deines et al. (1989)
p38a	-5.96	Deines et al. (1989)
p66a	-5.80	Deines et al. (1989)
f88	-5.79	Deines et al. (1989)
p112a	-5.75	Deines et al. (1989)
p109a	-5.49	Deines et al. (1989)
p110b	-5.43	Deines et al. (1989)
p105a	-5.41	Deines et al. (1989)
p111a	-5.28	Deines et al. (1989)
p81a	-5.27	Deines et al. (1989)
p29a	-5.26	Deines et al. (1989)
p87a	-5.24	Deines et al. (1989)
p67a	-5.21	Deines et al. (1989)
p82a	-5.21	Deines et al. (1989)
p16	-5.18	Deines et al. (1989)
p20	-5.14	Deines et al. (1989)
p108a	-5.13	Deines et al. (1989)
p47a	-5.12	Deines et al. (1989)
p89a	-5.09	Deines et al. (1989)
p26	-5.07	Deines et al. (1989)
p21	-5.03	Deines et al. (1989)
p1	-5.00	Deines et al. (1989)
p42a	-5.00	Deines et al. (1989)
p78a	-4.97	Deines et al. (1989)
p31a	-4.91	Deines et al. (1989)
f90	-4.90	Deines et al. (1989)
p64a	-4.89	Deines et al. (1989)
p61b	-4.88	Deines et al. (1989)
p80a	-4.87	Deines et al. (1989)
p56a	-4.85	Deines et al. (1989)
p71a	-4.82	Deines et al. (1989)
p73a	-4.82	Deines et al. (1989)
p15	-4.81	Deines et al. (1989)
f85	-4.80	Deines et al. (1989)
p14	-4.79	Deines et al. (1989)
p107a	-4.77	Deines et al. (1989)
p17	-4.77	Deines et al. (1989)
p103a	-4.76	Deines et al. (1989)
p37a	-4.76	Deines et al. (1989)
p58a	-4.76	Deines et al. (1989)
p106a	-4.74	Deines et al. (1989)
p44a	-4.74	Deines et al. (1989)
p69a	-4.68	Deines et al. (1989)

p12	-4.65	Deines et al. (1989)
p72a	-4.62	Deines et al. (1989)
p39a	-4.59	Deines et al. (1989)
p6	-4.54	Deines et al. (1989)
p3	-4.50	Deines et al. (1989)
p3b	-4.50	Deines et al. (1989)
p7	-4.49	Deines et al. (1989)
p5a	-4.47	Deines et al. (1989)
p45a	-4.45	Deines et al. (1989)
p74a	-4.45	Deines et al. (1989)
p34a	-4.44	Deines et al. (1989)
p65a	-4.41	Deines et al. (1989)
p95a	-4.29	Deines et al. (1989)
p18a	-4.27	Deines et al. (1989)
f20	-4.26	Deines et al. (1989)
p19	-4.24	Deines et al. (1989)
p96a	-4.24	Deines et al. (1989)
p75a	-4.23	Deines et al. (1989)
p46a	-4.22	Deines et al. (1989)
p116a	-4.20	Deines et al. (1989)
p76a	-4.14	Deines et al. (1989)
p77a	-4.07	Deines et al. (1989)
p59a	-4.00	Deines et al. (1989)
f68	-3.95	Deines et al. (1989)
p114b	-3.92	Deines et al. (1989)
p113a	-3.81	Deines et al. (1989)
f70a	-3.76	Deines et al. (1989)
f89a	-3.70	Deines et al. (1989)
p104a	-3.70	Deines et al. (1989)
p35a	-3.67	Deines et al. (1989)
p43a	-3.62	Deines et al. (1989)
p4	-3.52	Deines et al. (1989)
p54a	-3.48	Deines et al. (1989)
p55a	-3.41	Deines et al. (1989)
p2	-3.10	Deines et al. (1989)
f86	-3.06	Deines et al. (1989)
p115a	-2.80	Deines et al. (1989)
p62a	-2.53	Deines et al. (1989)
or054	-17.21	Deines et al. (1993)
or002	-17.05	Deines et al. (1993)
or051	-16.63	Deines et al. (1993)
or013	-14.96	Deines et al. (1993)
or028	-14.89	Deines et al. (1993)
or004	-14.11	Deines et al. (1993)
or020	-14.05	Deines et al. (1993)
or015	-13.64	Deines et al. (1993)
or017	-13.58	Deines et al. (1993)
or022	-13.46	Deines et al. (1993)
or057	-12.38	Deines et al. (1993)

or006	-9.76	Deines et al. (1993)
or029	-9.02	Deines et al. (1993)
or018	-8.39	Deines et al. (1993)
or018	-8.39	Deines et al. (1993)
v160a	-15.60	Deines et al. (2001)
v176a	-11.74	Deines et al. (2001)
v133	-5.71	Deines et al. (2001)
v181b	-5.27	Deines et al. (2001)
v158a	-5.21	Deines et al. (2001)
v180a	-5.04	Deines et al. (2001)
v156b+c	-4.95	Deines et al. (2001)
v53a	-4.87	Deines et al. (2001)
v56+56b	-4.82	Deines et al. (2001)
v157a	-4.70	Deines et al. (2001)
v178ab	-4.67	Deines et al. (2001)
v61	-4.44	Deines et al. (2001)
v55	-4.39	Deines et al. (2001)
JWR13 core	-14.13	Howell et al. (2020)
Aust 058 (1)	-11.78	Howell et al. (2020)
Aust 052 (1)	-11.50	Howell et al. (2020)
E17	-10.90	Howell et al. (2020)
ORS-30C (1)	-10.80	Howell et al. (2020)
E20 "rim"	-10.17	Howell et al. (2020)
Aust 087 "rim"	-9.31	Howell et al. (2020)
ddmi-037 "middle"	-9.28	Howell et al. (2020)
ORS-23 core	-8.38	Howell et al. (2020)
JWR26 middle	-6.95	Howell et al. (2020)
E18	-6.48	Howell et al. (2020)
JWR9 rim	-5.36	Howell et al. (2020)
JWR13 middle	-17.01	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR7 core	-13.06	l et al. (2020; δ13C); Stachel et al. (in prep;
Aust 058 (1)	-12.13	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-14	-12.11	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-15 core	-11.92	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-15 middle	-11.56	l et al. (2020; δ13C); Stachel et al. (in prep;
Aust 052 (2)	-11.45	l et al. (2020; δ13C); Stachel et al. (in prep;
ddmi-048	-11.22	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-30C (2)	-10.63	l et al. (2020; δ13C); Stachel et al. (in prep;
Aust 046 "core"	-10.55	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-16	-10.33	l et al. (2020; δ13C); Stachel et al. (in prep;
Aust 046 "rim"	-10.06	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-30B	-10.05	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-30C (1)	-10.02	l et al. (2020; δ13C); Stachel et al. (in prep;
E20 "core"	-9.76	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-1 rim	-9.50	l et al. (2020; δ13C); Stachel et al. (in prep;
Aust 087 "core"	-9.50	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-5 core	-9.47	l et al. (2020; δ13C); Stachel et al. (in prep;
E21	-9.36	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-22 rim	-9.03	l et al. (2020; δ13C); Stachel et al. (in prep;

ddmi-037 "core"	-8.44	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-9 rim	-8.42	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-11 (2)	-7.84	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-11 (1)	-7.63	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR22 core	-7.33	l et al. (2020; δ13C); Stachel et al. (in prep;
Aust 053 (1)	-7.22	l et al. (2020; δ13C); Stachel et al. (in prep;
Aust 053 (2)	-7.19	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-5 rim	-6.75	l et al. (2020; δ13C); Stachel et al. (in prep;
E24 (3)	-6.75	l et al. (2020; δ13C); Stachel et al. (in prep;
E24 (1)	-6.72	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-6 "core"	-6.60	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-30C (2)	-6.52	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR21 middle	-6.33	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-5	-6.32	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR24 (1)	-6.27	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR24 (2)	-6.23	l et al. (2020; δ13C); Stachel et al. (in prep;
E24 (2)	-6.21	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-4 "core"	-6.20	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR19	-6.20	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-1 core	-6.19	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR3 core	-6.07	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-10	-6.06	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-9 core	-6.01	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-16 (1)	-5.85	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR21 core	-5.84	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR24 (3)	-5.80	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-4 "rim"	-5.75	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-9	-5.72	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-6 "rim"	-5.70	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-16 (2)	-5.69	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-3	-5.55	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR2	-5.49	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR16	-5.41	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR27 core	-5.33	l et al. (2020; δ13C); Stachel et al. (in prep;
ddmi-078	-5.33	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-13 "core"	-5.27	l et al. (2020; δ13C); Stachel et al. (in prep;
ddmi-127	-5.26	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR25	-5.23	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR6 rim	-5.23	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR26 rim	-5.23	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-13 "rim"	-5.19	l et al. (2020; δ13C); Stachel et al. (in prep;
ddmi-093	-5.19	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-23 rim	-5.15	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR9 middle	-5.13	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR22 rim	-5.11	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR13 rim	-5.09	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-6 "middle"	-5.08	l et al. (2020; δ13C); Stachel et al. (in prep;
ddmi-196	-5.08	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-16 (1)	-5.08	l et al. (2020; δ13C); Stachel et al. (in prep;

ORS-31B	-5.07	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-15 rim	-5.05	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR10	-4.97	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR7 rim	-4.97	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-22 core	-4.96	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-12	-4.93	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-31C	-4.93	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR3 rim	-4.84	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR21 rim	-4.81	l et al. (2020; δ13C); Stachel et al. (in prep;
ddmi-186	-4.73	l et al. (2020; δ13C); Stachel et al. (in prep;
ORS-22 middle	-4.71	l et al. (2020; δ13C); Stachel et al. (in prep;
ddmi-205	-4.71	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR1 rim	-4.69	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR9 core	-4.64	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR27 rim	-4.62	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR1 core	-4.58	l et al. (2020; δ13C); Stachel et al. (in prep;
ddmi-208	-4.54	l et al. (2020; δ13C); Stachel et al. (in prep;
ddmi-037 "rim"	-4.53	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR6 core	-4.53	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR26 core	-3.95	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR22 middle	-3.83	l et al. (2020; δ13C); Stachel et al. (in prep;
DP-16 (2)	-3.50	l et al. (2020; δ13C); Stachel et al. (in prep;
JWR1 middle	-2.36	l et al. (2020; δ13C); Stachel et al. (in prep;
CA14-A	-16.08	Melton (2013)
KW 112	-21.55	Motsamai (2018, PhD thesis)
KW 117	-21.43	Motsamai (2018, PhD thesis)
KW 119	-12.49	Motsamai (2018, PhD thesis)
KW 116	-11.36	Motsamai (2018, PhD thesis)
KW 113	-10.67	Motsamai (2018, PhD thesis)
KW 104	-10.31	Motsamai (2018, PhD thesis)
KW 087	-8.55	Motsamai (2018, PhD thesis)
KW 056	-7.76	Motsamai (2018, PhD thesis)
KW 088	-7.68	Motsamai (2018, PhD thesis)
KW 067	-7.53	Motsamai (2018, PhD thesis)
KW 094	-7.15	Motsamai (2018, PhD thesis)
KW 036	-7.00	Motsamai (2018, PhD thesis)
KW 097	-6.59	Motsamai (2018, PhD thesis)
KW 092	-6.08	Motsamai (2018, PhD thesis)
KW 068	-5.87	Motsamai (2018, PhD thesis)
KW 081	-5.64	Motsamai (2018, PhD thesis)
KW 083	-5.53	Motsamai (2018, PhD thesis)
KW 118	-5.42	Motsamai (2018, PhD thesis)
KW 080	-5.41	Motsamai (2018, PhD thesis)
KW 065	-5.11	Motsamai (2018, PhD thesis)
KW 114	-5.02	Motsamai (2018, PhD thesis)
KW 082	-5.00	Motsamai (2018, PhD thesis)
KW 076	-4.98	Motsamai (2018, PhD thesis)
KW 045	-4.94	Motsamai (2018, PhD thesis)
KW 066	-4.92	Motsamai (2018, PhD thesis)

KW 041	-4.91	Motsamai (2018, PhD thesis)
KW 055	-4.89	Motsamai (2018, PhD thesis)
KW 063	-4.87	Motsamai (2018, PhD thesis)
KW 054	-4.85	Motsamai (2018, PhD thesis)
KW 016	-4.84	Motsamai (2018, PhD thesis)
KW 059	-4.84	Motsamai (2018, PhD thesis)
KW 105	-4.80	Motsamai (2018, PhD thesis)
KW 095	-4.75	Motsamai (2018, PhD thesis)
KW 064	-4.74	Motsamai (2018, PhD thesis)
KW 100	-4.73	Motsamai (2018, PhD thesis)
KW 089	-4.72	Motsamai (2018, PhD thesis)
KW 035	-4.70	Motsamai (2018, PhD thesis)
KW 084	-4.66	Motsamai (2018, PhD thesis)
KW 014	-4.65	Motsamai (2018, PhD thesis)
KW 091	-4.63	Motsamai (2018, PhD thesis)
KW 120	-4.61	Motsamai (2018, PhD thesis)
KW 061	-4.61	Motsamai (2018, PhD thesis)
KW 037	-4.60	Motsamai (2018, PhD thesis)
KW 039	-4.59	Motsamai (2018, PhD thesis)
KW 040	-4.57	Motsamai (2018, PhD thesis)
KW 115	-4.57	Motsamai (2018, PhD thesis)
KW 060	-4.55	Motsamai (2018, PhD thesis)
KW 051	-4.54	Motsamai (2018, PhD thesis)
KW 058	-4.50	Motsamai (2018, PhD thesis)
KW 108	-4.46	Motsamai (2018, PhD thesis)
KW 009	-4.44	Motsamai (2018, PhD thesis)
KW 102	-4.16	Motsamai (2018, PhD thesis)
KW 079	-4.16	Motsamai (2018, PhD thesis)
KW 038	-4.04	Motsamai (2018, PhD thesis)
KW 052	-3.86	Motsamai (2018, PhD thesis)
KW 106	-3.80	Motsamai (2018, PhD thesis)
KW 078	-3.76	Motsamai (2018, PhD thesis)
KW 028	-2.53	Motsamai (2018, PhD thesis)
KK-068	-10.40	Palot et al. (2012)
KK-067	-9.20	Palot et al. (2012)
KK-040	-5.10	Palot et al. (2012)
KK-003	-4.80	Palot et al. (2012)
KK-075	-4.80	Palot et al. (2012)
KK-086	-4.80	Palot et al. (2012)
KK-080	-4.70	Palot et al. (2012)
KK-077	-2.00	Palot et al. (2012)
KK-004	-0.80	Palot et al. (2012)
HI-136	-27.20	Shatsky et al (2014)
HI-21	-26.00	Shatsky et al (2014)
HI-23	-23.50	Shatsky et al (2014)
_9-3_1	-22.70	Shatsky et al (2014)
HI-82	-22.10	Shatsky et al (2014)
HI-57	-20.40	Shatsky et al (2014)
86	-19.20	Shatsky et al (2014)

HI-48	-17.30	Shatsky et al (2014)
HI-121	-11.50	Shatsky et al (2014)
HI-159_1	-7.50	Shatsky et al (2014)
HI-147	-7.20	Shatsky et al (2014)
HI-50	-6.80	Shatsky et al (2014)
IST-49	-6.70	Shatsky et al (2014)
HI-145	-6.50	Shatsky et al (2014)
HI-146	-6.10	Shatsky et al (2014)
HI-22	-6.00	Shatsky et al (2014)
HI-55	-6.00	Shatsky et al (2014)
HI-9	-5.40	Shatsky et al (2014)
HI-149	-5.10	Shatsky et al (2014)
HI-52	-4.80	Shatsky et al (2014)
HI-49_1	-4.70	Shatsky et al (2014)
HI-46	-4.60	Shatsky et al (2014)
HI-34	-4.50	Shatsky et al (2014)
HH-7	-3.10	Shatsky et al (2014)
G036	-3.85	Stachel & Harris (1997), Melton (2013)
KK-018	-16.25	Stachel et al. (2002)
KK-101	-5.78	Stachel et al. (2002)
KK-042	-5.11	Stachel et al. (2002)
KK-024	-3.40	Stachel et al. (2002)
KK-097	-1.54	Stachel et al. (2002)
BV34-A	-4.44	Tappert et al. (2006), Melton (2013)
VMS401-3	-15.00	Wescott/Stachel 2014 (BSc Thesis; Unpubl)
VMS403	-9.79	Wescott/Stachel 2014 (BSc Thesis; Unpubl)
VMO201-1	-8.47	Wescott/Stachel 2014 (BSc Thesis; Unpubl)
VMC23-1	-5.71	Wescott/Stachel 2014 (BSc Thesis; Unpubl)
VMC07-2	-5.70	Wescott/Stachel 2014 (BSc Thesis; Unpubl)
VSS404-1	-4.94	Wescott/Stachel 2014 (BSc Thesis; Unpubl)
VMS402	-4.65	Wescott/Stachel 2014 (BSc Thesis; Unpubl)
VMO206-1	-4.61	Wescott/Stachel 2014 (BSc Thesis; Unpubl)
401P(II)	-40.73	De Stefano et al. (2009)
344X (1)	-40.14	De Stefano et al. (2009)
414	-39.55	De Stefano et al. (2009)
256X (1)	-39.12	De Stefano et al. (2009)
611 (1)	-39.12	De Stefano et al. (2009)
389G	-39.06	De Stefano et al. (2009)
052P	-39.04	De Stefano et al. (2009)
051G(II)	-38.44	De Stefano et al. (2009)
303Q	-37.98	De Stefano et al. (2009)
355Q	-37.93	De Stefano et al. (2009)
331G	-37.42	De Stefano et al. (2009)
280X (1)	-36.23	De Stefano et al. (2009)
302Q (1)	-35.86	De Stefano et al. (2009)
401	-35.70	De Stefano et al. (2009)
284X (2)	-35.67	De Stefano et al. (2009)
338R	-35.38	De Stefano et al. (2009)
076G (1)	-35.22	De Stefano et al. (2009)

345P (7)	-35.16	De Stefano et al. (2009)
255X	-35.03	De Stefano et al. (2009)
395G(II) (2)	-34.22	De Stefano et al. (2009)
384R (1)	-34.03	De Stefano et al. (2009)
298R (1)	-33.66	De Stefano et al. (2009)
171G (1)	-33.44	De Stefano et al. (2009)
365X	-32.68	De Stefano et al. (2009)
405X (1)	-32.04	De Stefano et al. (2009)
397P	-31.35	De Stefano et al. (2009)
363R (1)	-30.99	De Stefano et al. (2009)
052G(I)	-30.39	De Stefano et al. (2009)
377X (1)	-29.74	De Stefano et al. (2009)
401P(I) (1)	-29.70	De Stefano et al. (2009)
308G(IV)	-29.60	De Stefano et al. (2009)
393G (1)	-29.39	De Stefano et al. (2009)
Guan-2089	-28.70	Kaminsky et al. (2000)
058 (2)	-26.03	De Stefano et al. (2009)
390R	-25.72	De Stefano et al. (2009)
C-118	-25.05	Kaminsky et al. (2009b)
Guan-1448	-24.60	Kaminsky et al. (2000)
Zimmi14 rim	-24.48	Smit et al. (2019)
JF-066	-24.22	Tappert et al. (2005a)
Gm-100	-23.90	Sobolev et al. (1998b)
JF-048	-23.60	Tappert et al. (2005a)
Zimmi14 core	-23.45	Smit et al. (2019)
Zimmi11 rim	-23.31	Smit et al. (2019)
Guan-2212	-23.30	Kaminsky et al. (2000)
Zimmi11 core	-23.18	Smit et al. (2019)
Guan-2208	-23.10	Kaminsky et al. (2000)
JF-080	-22.76	Tappert et al. (2005a)
JF-051	-22.61	Tappert et al. (2005a)
Guan-V-27	-22.00	Kaminsky et al. (2000)
Guan-014	-21.20	Kaminsky et al. (2000)
DO27-97 23J	-21.05	Davies et al. (1999)
Guan-2138	-20.90	Kaminsky et al. (2000)
C-133	-20.71	Kaminsky et al. (2009b)
Guan-051b	-20.70	Kaminsky et al. (2000)
Ash-111F	-20.60	Davies et al. (2004b)
J219	-20.43	Deines & Harris (1995)
J208	-20.15	Deines & Harris (1995)
J202	-19.79	Deines & Harris (1995)
JF-019	-19.76	Tappert et al. (2005a)
JF-034	-19.29	Tappert et al. (2005a)
J201	-19.23	Deines & Harris (1995)
Guan-051a	-19.10	Kaminsky et al. (2000)
DO2700166	-19.00	Davies et al. (2004a)
U47A	-18.93	Laiginhas (2008)
Ash-102A	-18.80	Davies et al. (2004b)
JW00 19	-18.73	Thommasot et al. (2009)

AGN-52	-18.68	Sobolev et al. (1989)
J213	-18.62	Deines & Harris (1995)
Guan-037a	-18.60	Kaminsky et al. (2000)
DO2700227	-18.60	Davies et al. (2004a)
JF-026	-18.40	Tappert et al. (2005a)
DO2700042	-18.40	Davies et al. (2004a)
Guan-063b	-18.30	Kaminsky et al. (2000)
Ik 77	-18.30	Deines & Harris (2004)
JF-068	-18.24	Tappert et al. (2005a)
Guan-V-19	-18.20	Kaminsky et al. (2000)
JF-096	-18.12	Tappert et al. (2005a)
DO27-98 29(2)	-18.01	Davies et al. (1999)
DO27-98 33	-17.97	Davies et al. (1999)
JF-038	-17.92	Tappert et al. (2005a)
Guan-2220	-17.90	Kaminsky et al. (2000)
Guan-V-29	-17.90	Kaminsky et al. (2000)
Guan-043	-17.70	Kaminsky et al. (2000)
J211	-17.70	Deines & Harris (1995)
Guan-004	-17.60	Kaminsky et al. (2000)
dam 05	-17.60	Deines et al. (2009)
A115-1	-17.60	Banas et al. (2006)
AGS-12	-17.52	Sobolev et al. (1989)
U25A	-17.48	Laiginhas (2008)
J221	-17.47	Deines & Harris (1995)
JF-040	-17.40	Tappert et al. (2005a)
A110	-17.38	Banas et al. (2006)
Guan-1451	-17.30	Kaminsky et al. (2000)
JF-072	-17.20	Tappert et al. (2005a)
Guan-V-33	-17.10	Kaminsky et al. (2000)
J203	-17.05	Deines & Harris (1995)
Guan-V-20	-17.00	Kaminsky et al. (2000)
DO2700006	-17.00	Davies et al. (2004a)
Guan-053	-16.90	Kaminsky et al. (2000)
Ik 66	-16.86	Deines & Harris (2004)
B4WK2-2	-16.85	Xia (2018）
AGN-34	-16.80	Sobolev et al. (1989)
Guan-063a	-16.70	Kaminsky et al. (2000)
Guan-V-32	-16.70	Kaminsky et al. (2000)
Ik 72	-16.66	Deines & Harris (2004)
AGS-06	-16.46	Sobolev et al. (1989)
dam 95	-16.43	Deines et al. (2009)
Guan-1991	-16.40	Kaminsky et al. (2000)
Zimmi15 core	-16.39	Smit et al. (2019)
Zimmi15 rim	-16.36	Smit et al. (2019)
JF-070	-16.35	Tappert et al. (2005a)
Guan-052	-16.30	Kaminsky et al. (2000)
dam 21A	-16.24	Deines et al. (2009)
JF-047	-15.96	Tappert et al. (2005a)
J209	-15.94	Deines & Harris (1995)

Guan-1815	-15.90	Kaminsky et al. (2000)
Aust 093	-15.89	Stachel et al. (2018a)
a136	-15.85	Jaques et al. (1989)
DO27-97 22I	-15.77	Davies et al. (1999)
JF-041	-15.62	Tappert et al. (2005a)
Aust 077	-15.61	Stachel et al. (2018a)
Gm-24	-15.50	Sobolev et al. (1998b)
Guan-006a	-15.50	Kaminsky et al. (2000)
Guan-019	-15.40	Kaminsky et al. (2000)
JF-052	-15.40	Tappert et al. (2005a)
dam 17	-15.32	Deines et al. (2009)
Guan-V-25	-15.30	Kaminsky et al. (2000)
Guan-V-25	-15.30	Kaminsky et al. (2000)
Guan-V-9	-15.20	Kaminsky et al. (2000)
A119-1	-15.12	Banas et al. (2006)
Guan-012a	-15.10	Kaminsky et al. (2000)
Guan-1810	-14.90	Kaminsky et al. (2000)
Guan-V-14	-14.90	Kaminsky et al. (2000)
Aust 148	-14.78	Stachel et al. (2018a)
Ash-111D-1	-14.70	Davies et al. (2004b)
Guan-001	-14.70	Kaminsky et al. (2000)
dam 58	-14.63	Deines et al. (2009)
Ash-111C	-14.60	Davies et al. (2004b)
a080	-14.60	Jaques AL in GSC (1989, Open File 2124)
Guan-V-11	-14.50	Kaminsky et al. (2000)
Guan-064a	-14.40	Kaminsky et al. (2000)
Guan-V-23	-14.40	Kaminsky et al. (2000)
Guan-V-7	-14.40	Kaminsky et al. (2000)
e9/8	-14.40	Jaques et al. (1989)
AGN-48	-14.37	Sobolev et al. (1989)
JF-063	-14.26	Tappert et al. (2005a)
Aust 059	-14.21	Stachel et al. (2018a)
Aust 032	-14.16	Stachel et al. (2018)
Gm-32	-14.10	Sobolev et al. (1998b)
a063	-14.10	Jaques AL in GSC (1989, Open File 2124)
lk 68	-14.07	Deines & Harris (2004)
JF110	-13.93	Tappert et al. (2005a)
Guan-2127	-13.90	Kaminsky et al. (2000)
SL5-86	-13.90	Pokhilenko et al. (2004)
dam 54	-13.73	Deines et al. (2009)
Ash-111G	-13.70	Davies et al. (2004b)
Guan-V-6	-13.70	Kaminsky et al. (2000)
Guan-V-22	-13.60	Kaminsky et al. (2000)
Aust 043	-13.59	Stachel et al. (2018)
AGS-19	-13.44	Sobolev et al. (1989)
Guan-055	-13.40	Kaminsky et al. (2000)
a039c	-13.40	Jaques AL in GSC (1989, Open File 2124)
a139	-13.40	Jaques et al. (1989)
DO27-98 28(2)	-13.36	Davies et al. (1999)

Ud-81/32	-13.36	Sobolev et al. (2009)
AGN-31	-13.30	Sobolev et al. (1989)
Aust 048	-13.29	Stachel et al. (2018)
Aust 126	-13.24	Stachel et al. (2018a)
Aust 036	-12.99	Stachel et al. (2018)
JF-056	-12.98	Tappert et al. (2005a)
Guan-010a	-12.90	Kaminsky et al. (2000)
a069	-12.90	Jaques AL in GSC (1989, Open File 2124)
a069r	-12.90	Jaques AL in GSC (1989, Open File 2124)
Aust 082	-12.89	Stachel et al. (2018a)
dam 59A	-12.87	Deines et al. (2009)
E02	-12.86	Stachel et al. (2018a)
Guan-060	-12.80	Kaminsky et al. (2000)
Guan-V-30	-12.80	Kaminsky et al. (2000)
a083c	-12.80	Jaques AL in GSC (1989, Open File 2124)
Aust 069	-12.76	Stachel et al. (2018a)
AGN-29	-12.72	Sobolev et al. (1989)
Guan-2217	-12.70	Kaminsky et al. (2000)
Guan-V-24	-12.70	Kaminsky et al. (2000)
DO2700145	-12.70	Davies et al. (2004a)
Aust 088	-12.69	Stachel et al. (2018a)
Aust 063	-12.68	Stachel et al. (2018a)
E22	-12.65	Stachel et al. (2018a)
KGR-16	-12.61	Sobolev et al. (1989)
Guan-V-17 (1)	-12.60	Kaminsky et al. (2000)
bz124-1	-12.57	Wilding (1990)
Aust 050	-12.56	Stachel et al. (2018)
a084	-12.50	Jaques et al. (1989)
a141	-12.50	Jaques AL in GSC (1989, Open File 2124)
a031	-12.40	Jaques et al. (1989)
AGS-25	-12.35	Sobolev et al. (1989)
E04	-12.32	Stachel et al. (2018a)
Guan-2214	-12.30	Kaminsky et al. (2000)
Guan-V-8	-12.30	Kaminsky et al. (2000)
a044	-12.30	Jaques et al. (1989)
a055	-12.30	Jaques AL in GSC (1989, Open File 2124)
a075c	-12.30	Jaques AL in GSC (1989, Open File 2124)
Guan-1877	-12.20	Kaminsky et al. (2000)
a079	-12.20	Jaques AL in GSC (1989, Open File 2124)
a005	-12.10	Jaques AL in GSC (1989, Open File 2124)
a064	-12.10	Jaques AL in GSC (1989, Open File 2124)
a077c	-12.10	Jaques AL in GSC (1989, Open File 2124)
DO27-98 20	-12.10	Davies et al. (1999)
Aust 076	-12.09	Stachel et al. (2018a)
Aust 076	-12.09	Stachel et al. (2018a)
Aust 055	-12.09	Stachel et al. (2018a)
Aust 105	-12.04	Stachel et al. (2018a)
a030	-12.00	Jaques et al. (1989)
a050c	-12.00	Jaques AL in GSC (1989, Open File 2124)

a065	-12.00	Jaques AL in GSC (1989, Open File 2124)
a068	-12.00	Jaques et al. (1989)
Aust 062	-11.96	Stachel et al. (2018a)
AGN-49	-11.94	Sobolev et al. (1989)
DO27-98 17(3)	-11.94	Davies et al. (1999)
Aust 118	-11.92	Stachel et al. (2018a)
U15A	-11.91	Laiginhas (2008)
a054c	-11.90	Jaques AL in GSC (1989, Open File 2124)
a070	-11.90	Jaques AL in GSC (1989, Open File 2124)
AGN-42	-11.90	Sobolev et al. (1989)
E23	-11.90	Stachel et al. (2018a)
Aust 150	-11.89	Stachel et al. (2018a)
Aust 150	-11.89	Stachel et al. (2018a)
AGS-05	-11.89	Sobolev et al. (1989)
E15	-11.88	Stachel et al. (2018a)
Aust 078	-11.87	Stachel et al. (2018a)
Aust 142	-11.86	Stachel et al. (2018a)
Aust 041	-11.83	Stachel et al. (2018)
Guan-V-15 (1)	-11.80	Kaminsky et al. (2000)
E01	-11.80	Stachel et al. (2018a)
Aust 081	-11.76	Stachel et al. (2018a)
Aust 068	-11.75	Stachel et al. (2018a)
bz125-2	-11.75	Wilding (1990)
Ik 63	-11.73	Deines & Harris (2004)
Aust 089	-11.71	Stachel et al. (2018a)
Guan-013	-11.70	Kaminsky et al. (2000)
a057c	-11.70	Jaques AL in GSC (1989, Open File 2124)
a059c	-11.70	Jaques AL in GSC (1989, Open File 2124)
a109	-11.70	Jaques AL in GSC (1989, Open File 2124)
a110	-11.70	Jaques AL in GSC (1989, Open File 2124)
Aust 147	-11.69	Stachel et al. (2018a)
AGN-41	-11.67	Sobolev et al. (1989)
a133	-11.65	Jaques AL in GSC (1989, Open File 2124)
Aust 074	-11.63	Stachel et al. (2018a)
Guan-024	-11.60	Kaminsky et al. (2000)
a107	-11.60	Jaques AL in GSC (1989, Open File 2124)
a144	-11.60	Jaques AL in GSC (1989, Open File 2124)
AGS-17	-11.59	Sobolev et al. (1989)
E11	-11.56	Stachel et al. (2018a)
E29	-11.56	Stachel et al. (2018a)
a140	-11.55	Jaques AL in GSC (1989, Open File 2124)
AGS-16	-11.53	Sobolev et al. (1989)
a004	-11.50	Jaques AL in GSC (1989, Open File 2124)
a014	-11.50	Jaques AL in GSC (1989, Open File 2124)
a036c	-11.50	Jaques et al. (1989)
E06	-11.50	Stachel et al. (2018a)
Aust 143	-11.41	Stachel et al. (2018a)
a009	-11.40	Jaques AL in GSC (1989, Open File 2124)
AGS-01	-11.38	Sobolev et al. (1989)

Aust 094	-11.37	Stachel et al. (2018a)
a001	-11.30	Jaques AL in GSC (1989, Open File 2124)
a015	-11.30	Jaques AL in GSC (1989, Open File 2124)
DO2700007	-11.30	Davies et al. (2004a)
Aust 065	-11.29	Stachel et al. (2018a)
Aust 149	-11.28	Stachel et al. (2018a)
e9/14	-11.25	Jaques et al. (1989)
Aust 141	-11.23	Stachel et al. (2018a)
Aust 049	-11.23	Stachel et al. (2018)
AGS-15	-11.22	Sobolev et al. (1989)
llt 28	-11.20	McDade & Harris (1999)
a025	-11.20	Jaques AL in GSC (1989, Open File 2124)
a026	-11.20	Jaques AL in GSC (1989, Open File 2124)
Aust 106	-11.15	Stachel et al. (2018a)
Aust 146	-11.13	Stachel et al. (2018a)
Aust 047	-11.11	Stachel et al. (2018)
E13	-11.10	Stachel et al. (2018a)
dam 57	-11.00	Deines et al. (2009)
a032a	-11.00	Jaques AL in GSC (1989, Open File 2124)
a121	-11.00	Jaques AL in GSC (1989, Open File 2124)
AGN-46	-10.98	Sobolev et al. (1989)
Aust 080	-10.95	Stachel et al. (2018a)
lk 75	-10.94	Deines & Harris (2004)
Aust 104	-10.94	Stachel et al. (2018a)
Aust 034	-10.93	Stachel et al. (2018)
Aust 132	-10.93	Stachel et al. (2018a)
E07	-10.92	Stachel et al. (2018a)
S5304 core	-10.91	Bulbuc/Stachel 2018 (BSc Thesis; Unpubl)
Aust 083	-10.91	Stachel et al. (2018a)
a049c	-10.90	Jaques AL in GSC (1989, Open File 2124)
a078	-10.90	Jaques et al. (1989)
a119	-10.90	Jaques AL in GSC (1989, Open File 2124)
AGS-21	-10.89	Sobolev et al. (1989)
Aust 075	-10.86	Stachel et al. (2018a)
a106	-10.85	Jaques AL in GSC (1989, Open File 2124)
Aust 079	-10.81	Stachel et al. (2018a)
Aust 054	-10.80	Stachel et al. (2018a)
a081	-10.80	Jaques AL in GSC (1989, Open File 2124)
dam 13	-10.78	Deines et al. (2009)
AGN-53	-10.76	Sobolev et al. (1989)
AGS-03	-10.76	Sobolev et al. (1989)
lk 64	-10.75	Deines & Harris (2004)
Aust 033	-10.75	Stachel et al. (2018)
a086	-10.70	Jaques AL in GSC (1989, Open File 2124)
aA17	-10.70	Jaques et al. (1989)
a132	-10.65	Jaques AL in GSC (1989, Open File 2124)
Aust 064	-10.62	Stachel et al. (2018a)
Aust 108	-10.62	Stachel et al. (2018a)
AGN-45	-10.61	Sobolev et al. (1989)

a089	-10.60	Jaques AL in GSC (1989, Open File 2124)
E08	-10.52	Stachel et al. (2018a)
dam 04	-10.51	Deines et al. (2009)
Aust 112	-10.50	Stachel et al. (2018a)
a019	-10.50	Jaques AL in GSC (1989, Open File 2124)
a043	-10.50	Jaques AL in GSC (1989, Open File 2124)
Aust 066	-10.50	Stachel et al. (2018a)
Aust 144	-10.49	Stachel et al. (2018a)
Aust 060	-10.49	Stachel et al. (2018a)
Aust 037	-10.47	Stachel et al. (2018)
Aust 057	-10.47	Stachel et al. (2018a)
Aust 085	-10.42	Stachel et al. (2018a)
Guan-012	-10.40	Kaminsky et al. (2000)
a028	-10.40	Jaques AL in GSC (1989, Open File 2124)
a125	-10.40	Jaques AL in GSC (1989, Open File 2124)
Aust 137	-10.40	Stachel et al. (2018a)
a127	-10.35	Jaques AL in GSC (1989, Open File 2124)
AGN-44	-10.33	Sobolev et al. (1989)
a045c	-10.30	Jaques AL in GSC (1989, Open File 2124)
a120	-10.30	Jaques AL in GSC (1989, Open File 2124)
Aust 038	-10.29	Stachel et al. (2018)
Aust 042	-10.26	Stachel et al. (2018)
Aust 101	-10.25	Stachel et al. (2018a)
Aust 129	-10.22	Stachel et al. (2018a)
Aust 102	-10.19	Stachel et al. (2018a)
dam 40	-10.16	Deines et al. (2009)
Aust 086	-10.11	Stachel et al. (2018a)
Guan-V-21 (1)	-10.10	Kaminsky et al. (2000)
a108	-10.10	Jaques AL in GSC (1989, Open File 2124)
Aust 084	-10.07	Stachel et al. (2018a)
AGS-24	-10.04	Sobolev et al. (1989)
Aust 151	-10.01	Stachel et al. (2018a)
E30	-10.01	Stachel et al. (2018a)
a135	-10.00	Jaques AL in GSC (1989, Open File 2124)
AGN-43	-10.00	Sobolev et al. (1989)
Aust 109	-9.94	Stachel et al. (2018a)
Aust 097	-9.92	Stachel et al. (2018a)
Aust 051	-9.83	Stachel et al. (2018)
a027	-9.80	Jaques AL in GSC (1989, Open File 2124)
a033	-9.80	Jaques et al. (1989)
AGS-09	-9.71	Sobolev et al. (1989)
a042c	-9.60	Jaques AL in GSC (1989, Open File 2124)
a118	-9.60	Jaques AL in GSC (1989, Open File 2124)
KLD-4(-1)	-9.60	Schulze et al. (2008)
Aust 070	-9.58	Stachel et al. (2018a)
AGN-37	-9.54	Sobolev et al. (1989)
Aust 119	-9.53	Stachel et al. (2018a)
Guan-V-26 (1)	-9.50	Kaminsky et al. (2000)
a105	-9.50	Jaques AL in GSC (1989, Open File 2124)

a113	-9.50	Jaques AL in GSC (1989, Open File 2124)
a142	-9.50	Jaques AL in GSC (1989, Open File 2124)
E16	-9.47	Stachel et al. (2018a)
S5309	-9.46	Bulbuc/Stachel 2018 (BSc Thesis; Unpubl)
dam 56A	-9.41	Deines et al. (2009)
a085	-9.40	Jaques et al. (1989)
DO27000155	-9.40	Davies et al. (2004a)
DO2700155(1)	-9.40	Davies et al. (2004a)
a101	-9.35	Jaques AL in GSC (1989, Open File 2124)
a114	-9.35	Jaques AL in GSC (1989, Open File 2124)
JF-031	-9.22	Tappert et al. (2005a)
AGN-51	-9.21	Sobolev et al. (1989)
E14	-9.21	Stachel et al. (2018a)
a134	-9.20	Jaques AL in GSC (1989, Open File 2124)
DO2700052(1)	-9.20	Davies et al. (2004a)
dam 62A	-9.14	Deines et al. (2009)
a034	-9.10	Jaques AL in GSC (1989, Open File 2124)
a052r	-9.10	Jaques et al. (1989)
Aust 145	-9.05	Stachel et al. (2018a)
a111	-8.95	Jaques AL in GSC (1989, Open File 2124)
a116	-8.90	Jaques et al. (1989)
a126	-8.90	Jaques AL in GSC (1989, Open File 2124)
lk 70	-8.84	Deines & Harris (2004)
Aust 113	-8.83	Stachel et al. (2018a)
AGN-50	-8.82	Sobolev et al. (1989)
bz121-2	-8.75	Wilding (1990)
DO27000175	-8.60	Davies et al. (2004a)
dam 65A	-8.58	Deines et al. (2009)
dam 08A	-8.56	Deines et al. (2009)
lk 65	-8.55	Deines & Harris (2004)
Aust 107	-8.54	Stachel et al. (2018a)
Aust 040	-8.49	Stachel et al. (2018)
Aust 073	-8.46	Stachel et al. (2018a)
E12	-8.43	Stachel et al. (2018a)
JW95 03	-8.38	Thommasot et al. (2009)
JW95 18	-8.38	Thommasot et al. (2009)
JW94 08	-8.36	Thommasot et al. (2009)
DO27-97 23A(1)	-8.36	Davies et al. (1999)
KGR-10	-8.30	Sobolev et al. (1989)
U53A	-8.28	Laiginhas (2008)
Zimmi18 core	-8.25	Smit et al. (2019)
AGS-10	-8.23	Sobolev et al. (1989)
dam 61A	-8.22	Deines et al. (2009)
Aust 045	-8.15	Stachel et al. (2018)
DO2700152	-8.10	Davies et al. (2004a)
bz123	-8.02	Wilding (1990)
Zimmi18 rim	-8.01	Smit et al. (2019)
KLD-19	-8.00	Schulze et al. (2008)
dam 91	-7.99	Deines et al. (2009)

dam 88	-7.98	Deines et al. (2009)
Aust 031	-7.97	Stachel et al. (2018)
lk 57	-7.84	Deines & Harris (2004)
a038c	-7.80	Jaques AL in GSC (1989, Open File 2124)
A131	-7.69	Banas et al. (2006)
KGR-11	-7.60	Sobolev et al. (1989)
JW95 14	-7.57	Thommasot et al. (2009)
U83A	-7.52	Laiginhas (2008)
Aust 072	-7.46	Stachel et al. (2018a)
DO27000177(1)	-7.40	Davies et al. (2004a)
Zimmi20 core	-7.38	Smit et al. (2019)
JW94 01	-7.37	Thommasot et al. (2009)
lk 69	-7.33	Deines & Harris (2004)
E19	-7.33	Stachel et al. (2018a)
U86C	-7.24	Laiginhas (2008)
lk 55	-7.10	Deines & Harris (2004)
Aust 044	-7.09	Stachel et al. (2018)
dam 78	-6.99	Deines et al. (2009)
JW95 26	-6.98	Thommasot et al. (2009)
Guan-056	-6.90	Kaminsky et al. (2000)
A128	-6.84	Banas et al. (2006)
KLD-5	-6.80	Schulze et al. (2008)
U73A	-6.79	Laiginhas (2008)
U72F	-6.77	Laiginhas (2008)
Zimmi20 rim	-6.76	Smit et al. (2019)
U59A	-6.72	Laiginhas (2008)
bz128-1	-6.70	Wilding (1990)
lk 48	-6.63	Deines & Harris (2004)
a040c	-6.60	Jaques et al. (1989)
N5K2-5	-6.53	Xia (2018）
JW00 15	-6.50	Thommasot et al. (2009)
a122	-6.50	Jaques AL in GSC (1989, Open File 2124)
VR11492	-6.50	Davies et al. (2004a)
JW00 06	-6.46	Thommasot et al. (2009)
Aust 061	-6.46	Stachel et al. (2018a)
bz126-1	-6.42	Wilding (1990)
U38A	-6.42	Laiginhas (2008)
lk 73	-6.41	Deines & Harris (2004)
U74B	-6.41	Laiginhas (2008)
U33	-6.39	Laiginhas (2008)
Aust 103	-6.38	Stachel et al. (2018a)
Aust 067	-6.36	Stachel et al. (2018a)
JW95 10	-6.35	Thommasot et al. (2009)
U46A	-6.34	Laiginhas (2008)
e4/22	-6.30	Jaques et al. (1989)
U62B	-6.30	Laiginhas (2008)
U11A	-6.29	Laiginhas (2008)
U35A	-6.28	Laiginhas (2008)
U39A	-6.28	Laiginhas (2008)

U36A	-6.20	Laiginhas (2008)
Sp-727	-6.20	Sobolev et al. (2009)
U92B	-6.19	Laiginhas (2008)
JW00 20	-6.17	Thommasot et al. (2009)
U48A	-6.14	Laiginhas (2008)
U42A	-6.12	Laiginhas (2008)
a047c	-6.10	Jaques et al. (1989)
a117	-6.10	Jaques et al. (1989)
lk 50	-6.08	Deines & Harris (2004)
U34A	-6.07	Laiginhas (2008)
JW00 03	-6.01	Thommasot et al. (2009)
kv1-3	-6.00	Palot et al. (2009)
U13A dark	-6.00	Laiginhas (2008)
JW95 15	-5.98	Thommasot et al. (2009)
U50A	-5.93	Laiginhas (2008)
a145	-5.90	Jaques AL in GSC (1989, Open File 2124)
JW95 24	-5.89	Thommasot et al. (2009)
JW95 12-2	-5.87	Thommasot et al. (2009)
U61A	-5.84	Laiginhas (2008)
U68A	-5.82	Laiginhas (2008)
JW00 10	-5.81	Thommasot et al. (2009)
kv3-5	-5.80	Palot et al. (2009)
JW00 17	-5.78	Thommasot et al. (2009)
JW94 02	-5.78	Thommasot et al. (2009)
JW00 18	-5.77	Thommasot et al. (2009)
lk 47	-5.75	Deines & Harris (2004)
Aust 056	-5.72	Stachel et al. (2018a)
llt 05	-5.70	McDade & Harris (1999)
DO2700290A	-5.70	Davies et al. (2004a)
lk 51	-5.68	Deines & Harris (2004)
JW00 11	-5.67	Thommasot et al. (2009)
JW00 14	-5.67	Thommasot et al. (2009)
JW95 09	-5.67	Thommasot et al. (2009)
JW95 22	-5.67	Thommasot et al. (2009)
jw-009	-5.65	UCT database (1982)
lk 26	-5.65	Deines & Harris (2004)
U49A	-5.65	Laiginhas (2008)
B2K4-1	-5.65	Xia (2018）
JF-013	-5.64	Tappert et al. (2005a)
U82C	-5.63	Laiginhas (2008)
U54F	-5.61	Laiginhas (2008)
kv2-3	-5.60	Palot et al. (2009)
kv3-8	-5.60	Palot et al. (2009)
kv4-9	-5.60	Palot et al. (2009)
e4/13	-5.60	Jaques et al. (1989)
JW95 12	-5.58	Thommasot et al. (2009)
U79A	-5.58	Laiginhas (2008)
JF-092	-5.57	Tappert et al. (2005a)
JW00 07	-5.57	Thommasot et al. (2009)

lk 53	-5.57	Deines & Harris (2004)
JW00 02	-5.56	Thommasot et al. (2009)
dam 06	-5.56	Deines et al. (2009)
U56A	-5.53	Laiginhas (2008)
dam 75	-5.52	Deines et al. (2009)
dam 63	-5.51	Deines et al. (2009)
U52A	-5.51	Laiginhas (2008)
JW95 06	-5.50	Thommasot et al. (2009)
kv1-8	-5.50	Palot et al. (2009)
kv2-4	-5.50	Palot et al. (2009)
kv4-5	-5.50	Palot et al. (2009)
kv4-8	-5.50	Palot et al. (2009)
llt 11b	-5.50	McDade & Harris (1999)
a074c	-5.50	Jaques AL in GSC (1989, Open File 2124)
B2K4-14	-5.47	Xia (2018）
JW00 12	-5.45	Thommasot et al. (2009)
a128	-5.45	Jaques AL in GSC (1989, Open File 2124)
U55A	-5.45	Laiginhas (2008)
JW95 01	-5.44	Thommasot et al. (2009)
U93A	-5.41	Laiginhas (2008)
JF-095	-5.41	Tappert et al. (2005a)
JW95 05	-5.40	Thommasot et al. (2009)
kv4-7	-5.40	Palot et al. (2009)
U37A	-5.39	Laiginhas (2008)
U80A	-5.39	Laiginhas (2008)
J215	-5.38	Deines & Harris (1995)
JW00 04	-5.38	Thommasot et al. (2009)
U57A	-5.37	Laiginhas (2008)
U75D	-5.36	Laiginhas (2008)
DA007	-5.36	Aulbach et al. (2009)
JF-008	-5.33	Tappert et al. (2005a)
JW94 09	-5.30	Thommasot et al. (2009)
kv2-8	-5.30	Palot et al. (2009)
kv3-4	-5.30	Palot et al. (2009)
kv4-3	-5.30	Palot et al. (2009)
kv4-4	-5.30	Palot et al. (2009)
DO2700133	-5.30	Davies et al. (2004a)
ddmi-198	-5.27	Donnelly et al. (2007)
JW00 01	-5.27	Thommasot et al. (2009)
DA033	-5.27	Aulbach et al. (2009)
dam 15	-5.25	Deines et al. (2009)
JF-076	-5.24	Tappert et al. (2005a)
JW95 21	-5.23	Thommasot et al. (2009)
U84A	-5.22	Laiginhas (2008)
U44A	-5.21	Laiginhas (2008)
kv1-2	-5.20	Palot et al. (2009)
kv1-5	-5.20	Palot et al. (2009)
kv1-6	-5.20	Palot et al. (2009)
kv2-1	-5.20	Palot et al. (2009)

kv2-10	-5.20	Palot et al. (2009)
kv2-6	-5.20	Palot et al. (2009)
kv3-10	-5.20	Palot et al. (2009)
e4/7	-5.20	Jaques et al. (1989)
U60A	-5.19	Laiginhas (2008)
U76B	-5.17	Laiginhas (2008)
JF-077	-5.16	Tappert et al. (2005a)
DA018	-5.15	Aulbach et al. (2009)
JF-120	-5.13	Tappert et al. (2005a)
U02B	-5.13	Laiginhas (2008)
U32A	-5.12	Laiginhas (2008)
Sp-730	-5.12	Sobolev et al. (2009)
DA042	-5.11	Aulbach et al. (2009)
dam 76	-5.11	Deines et al. (2009)
U43A	-5.11	Laiginhas (2008)
kv1-4	-5.10	Palot et al. (2009)
kv2-5	-5.10	Palot et al. (2009)
kv3-6	-5.10	Palot et al. (2009)
kv4-1	-5.10	Palot et al. (2009)
JF-079	-5.10	Tappert et al. (2005a)
DA027	-5.09	Aulbach et al. (2009)
U41A	-5.08	Laiginhas (2008)
ddmi-193	-5.07	Donnelly et al. (2007)
dam 11	-5.03	Deines et al. (2009)
JW00 09	-5.00	Thommasot et al. (2009)
kv2-7	-5.00	Palot et al. (2009)
kv2-9	-5.00	Palot et al. (2009)
kv3-1	-5.00	Palot et al. (2009)
kv3-2	-5.00	Palot et al. (2009)
kv4-2	-5.00	Palot et al. (2009)
dam 67	-5.00	Deines et al. (2009)
DO27000200	-5.00	Davies et al. (2004a)
dam 71	-4.99	Deines et al. (2009)
U77B	-4.99	Laiginhas (2008)
U85A	-4.98	Laiginhas (2008)
DA016	-4.98	Aulbach et al. (2009)
JW95 25	-4.95	Thommasot et al. (2009)
lk 78	-4.95	Deines & Harris (2004)
JW95 11-2	-4.94	Thommasot et al. (2009)
N2K4-8 core	-4.93	Xia (2018）
DA020	-4.93	Aulbach et al. (2009)
DA043	-4.92	Aulbach et al. (2009)
JW00 16	-4.92	Thommasot et al. (2009)
DA025	-4.92	Aulbach et al. (2009)
DA029	-4.92	Aulbach et al. (2009)
DA040	-4.91	Aulbach et al. (2009)
N2K4-8 rim	-4.90	Xia (2018）
kv1-1	-4.90	Palot et al. (2009)
kv2-2	-4.90	Palot et al. (2009)

kv3-3	-4.90	Palot et al. (2009)
e4/17	-4.90	Jaques et al. (1989)
U71A	-4.90	Laiginhas (2008)
Sp-729	-4.90	Sobolev et al. (2009)
DA044	-4.89	Aulbach et al. (2009)
JF-081	-4.88	Tappert et al. (2005a)
DA063	-4.88	Aulbach et al. (2009)
JW00 08	-4.87	Thommasot et al. (2009)
DA050	-4.87	Aulbach et al. (2009)
JW95 08	-4.86	Thommasot et al. (2009)
JW94 05	-4.84	Thommasot et al. (2009)
JW94 09-2	-4.84	Thommasot et al. (2009)
dam 03	-4.84	Deines et al. (2009)
dam 18	-4.83	Deines et al. (2009)
dam 07	-4.82	Deines et al. (2009)
DA055	-4.82	Aulbach et al. (2009)
dam 09	-4.81	Deines et al. (2009)
DA026	-4.81	Aulbach et al. (2009)
Ash-108A	-4.80	Davies et al. (2004b)
DA010	-4.78	Aulbach et al. (2009)
JF-090	-4.77	Tappert et al. (2005a)
ddmi-166	-4.77	Donnelly et al. (2007)
JW95 07	-4.77	Thommasot et al. (2009)
DA022	-4.76	Aulbach et al. (2009)
B2K4-16	-4.75	Xia (2018）
dam 53A	-4.75	Deines et al. (2009)
U94B	-4.74	Laiginhas (2008)
DA021	-4.73	Aulbach et al. (2009)
JW00 05	-4.73	Thommasot et al. (2009)
DA009	-4.72	Aulbach et al. (2009)
kv4-6	-4.70	Palot et al. (2009)
Mr-597	-4.70	Sobolev et al. (2009)
JF-061	-4.69	Tappert et al. (2005a)
JW95 02	-4.68	Thommasot et al. (2009)
DA057	-4.64	Aulbach et al. (2009)
U58A	-4.64	Laiginhas (2008)
DA015	-4.64	Aulbach et al. (2009)
JW94 07-2	-4.62	Thommasot et al. (2009)
JW95 19	-4.61	Thommasot et al. (2009)
Sp-719	-4.61	Sobolev et al. (2009)
DA030	-4.59	Aulbach et al. (2009)
llt 02a	-4.58	McDade & Harris (1999)
JW95 20	-4.57	Thommasot et al. (2009)
dam 12	-4.56	Deines et al. (2009)
DA052	-4.56	Aulbach et al. (2009)
dam 10	-4.55	Deines et al. (2009)
dam 14	-4.55	Deines et al. (2009)
DA017	-4.54	Aulbach et al. (2009)
JW94 7-1	-4.54	Thommasot et al. (2009)

dam 19A	-4.53	Deines et al. (2009)
JW95 11	-4.51	Thommasot et al. (2009)
JW94 03	-4.50	Thommasot et al. (2009)
JW94 06	-4.50	Thommasot et al. (2009)
JF-011	-4.49	Tappert et al. (2005a)
JF-023	-4.48	Tappert et al. (2005a)
S5304 rim	-4.47	Bulbuc/Stachel 2018 (BSc Thesis; Unpubl)
DA024	-4.46	Aulbach et al. (2009)
JF-086	-4.46	Tappert et al. (2005a)
dam 20	-4.45	Deines et al. (2009)
DA047	-4.43	Aulbach et al. (2009)
lk 58	-4.42	Deines & Harris (2004)
DA039	-4.40	Aulbach et al. (2009)
JF-069	-4.39	Tappert et al. (2005a)
dam 16	-4.37	Deines et al. (2009)
JF-015	-4.36	Tappert et al. (2005a)
DA011	-4.34	Aulbach et al. (2009)
MW018	-4.34	Stachel et al. (1998)
JF-053	-4.33	Tappert et al. (2005a)
lk 52	-4.28	Deines & Harris (2004)
JF-059	-4.27	Tappert et al. (2005a)
lk 54	-4.26	Deines & Harris (2004)
U81B	-4.24	Laiginhas (2008)
lk 45	-4.23	Deines & Harris (2004)
lk 79	-4.22	Deines & Harris (2004)
kv3-9	-4.20	Palot et al. (2009)
DA028	-4.18	Aulbach et al. (2009)
306G(I)	-4.18	De Stefano et al. (2009)
JF-067	-4.15	Tappert et al. (2005a)
U51A	-4.13	Laiginhas (2008)
N2K4-5	-4.13	Xia (2018）
lk 56	-4.11	Deines & Harris (2004)
DO27-98 27F	-4.10	Davies et al. (1999)
JF-004	-4.07	Tappert et al. (2005a)
J212	-4.04	Deines & Harris (1995)
lk 76	-3.99	Deines & Harris (2004)
JF-012	-3.94	Tappert et al. (2005a)
JW95 20-2	-3.94	Thommasot et al. (2009)
A123	-3.94	Banas et al. (2006)
lk 46	-3.91	Deines & Harris (2004)
lk 46	-3.91	Deines & Harris (2004)
DA012	-3.89	Aulbach et al. (2009)
JF-020	-3.85	Tappert et al. (2005a)
e4/6	-3.80	Jaques et al. (1989)
dam 66	-3.78	Deines et al. (2009)
RV217	-3.74	Deines & Harris (1995)
JW94 04	-3.73	Thommasot et al. (2009)
A201	-3.65	Banas et al. (2006)
JF-091	-3.65	Tappert et al. (2005a)

_12006b	-3.64	Hunt et al. (2012)
_12006b	-3.64	Hunt et al. (2012)
Ik 71	-3.62	Deines & Harris (2004)
JW95 16	-3.42	Thommasot et al. (2009)
JF-111	-3.16	Tappert et al. (2005a)
JW00 13	-3.09	Thommasot et al. (2009)
RV205	-3.07	Deines & Harris (1995)
JW00 21	-2.00	Thommasot et al. (2009)
JF-074	-1.61	Tappert et al. (2005a)
DO27-98 27	-0.74	Davies et al. (1999)
W080	-0.40	Davies et al. (2003)
W085	2.10	Davies et al. (2003)

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Carbon isotopes database for diamonds

Sample	$\delta^{13}C_{VPDB}$
j27b-24	-22.20
j27a-24	-22.20
j13b-24	-21.13
Ash-105A(1)	-14.80
Ash-105A(2)	-14.80
Ash-108B(2)	-4.80
Ash-108B(3)	-4.80
Ash-108B(1)	-4.80
BZ215C	-8.85
BZ217A	-8.64
BZ218A	-7.90
BZ216A1	-6.23
BZ223A	-4.63
BZ223B	-4.63
Juina 5-108a	-11.40
Juina 5-108b	-11.40
Juina 5-108c	-11.40
KW 50a	-8.66
KW 57a	-5.28
KW 57d	-5.28
KW 38c	-4.04
SL5-86	-13.90
HH-11_1	-4.10
HH-11_2	-4.10
KK-81a	-3.13
KK-12	-2.95
KK-1a	0.89
WW-90A	-3.64
WW-90D	-3.64
WW-51A	-2.85
JF-58A	-23.01
JF-58B	-23.01
JF-09A	-21.82

JF-37A	-21.67
JF-37B	-21.67
JF-01A	-21.21
JF-01B	-21.21
JF-84A	-20.86
JF-50A	-19.88
JF-39A	-17.91
JF-44B	-17.71
JF-55A	-17.55
JF-55B	-17.55
JF-42A	-17.36
JF-22A	-17.25
bz122-5	-10.98
bz127-1	-8.37
bz129-1	-6.70

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Carbon concentration and isotopic composition database for ophiolitic, ultramafic complex, and active peridotite-hosted hydrothermal syste

Spl #	CO2 (ppm)	δ13C (‰)	Reference	Description
6	1746	-20.90	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
16a	1269	-26.50	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
16b	2823		Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
37	784	-22.70	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
52	1126	-21.00	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
66a	1643	-21.30	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
66b	1895	-24.60	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
87	1594	-17.20	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
102	874	-22.70	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
123	2409		Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
123	2335	-26.40	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
138	1839	-26.30	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
149	34,254		Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
150a	2629	-25.40	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
150b	973	-24.30	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
170	1209	-27.50	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
189	644	-28.40	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
196	564		Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
207	1158		Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
214	676		Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
220	945	-30.40	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
227	775	-28.10	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
231	652	-25.40	Shilobreeva et al. 2011	active hydrothermal system - East Pacific Rise
920D		1.10	Alt et al. 2003	active hydrothermal system - Mid-Atlantic Ridge
920D		2.90	Alt et al. 2003	active hydrothermal system - Mid-Atlantic Ridge
920D		4.50	Alt et al. 2003	active hydrothermal system - Mid-Atlantic Ridge
920B		3.20	Alt et al. 2003	active hydrothermal system - Mid-Atlantic Ridge
149_01	3.5	-2.50	Schwarzenbach 2011	Iberian Margin
149_02	1.3	-1.00	Schwarzenbach 2011	Iberian Margin
149_03	1.19	-1.40	Schwarzenbach 2011	Iberian Margin
149_04	6.18	-1.00	Schwarzenbach 2011	Iberian Margin
149_05	3.92	-2.10	Schwarzenbach 2011	Iberian Margin
149_07	2.4	-3.80	Schwarzenbach 2011	Iberian Margin

149_08	8.4	-0.20	Schwarzenbach 2011	Iberian Margin
149_09	0.295	-20.20	Schwarzenbach 2011	Iberian Margin
149_10	0.085	-21.10	Schwarzenbach 2011	Iberian Margin
149_11	0.047	-23.10	Schwarzenbach 2011	Iberian Margin
149_12	0.065	-19.40	Schwarzenbach 2011	Iberian Margin
149_14	0.04	-21.10	Schwarzenbach 2011	Iberian Margin
149_15	0.152	-21.30	Schwarzenbach 2011	Iberian Margin
149_16	0.142	-18.90	Schwarzenbach 2011	Iberian Margin
149_17	0.135	-19.70	Schwarzenbach 2011	Iberian Margin
149_18	0.083	-18.90	Schwarzenbach 2011	Iberian Margin
149_56	0.135	-4.30	Schwarzenbach 2011	Iberian Margin
149_57	0.135	-4.30	Schwarzenbach 2011	Iberian Margin
149_58	0.106	-5.70	Schwarzenbach 2011	Iberian Margin
149_19	1.9	-2.60	Schwarzenbach 2011	Iberian Margin
149_20	6.191	-0.10	Schwarzenbach 2011	Iberian Margin
149_21	9.629	1.30	Schwarzenbach 2011	Iberian Margin
149_22	4.469	-0.90	Schwarzenbach 2011	Iberian Margin
149_23	3.262	-1.00	Schwarzenbach 2011	Iberian Margin
149_24	4.47	-2.00	Schwarzenbach 2011	Iberian Margin
149_25	0.25	-4.30	Schwarzenbach 2011	Iberian Margin
149_26	2.68	-1.70	Schwarzenbach 2011	Iberian Margin
149_27	6.6	0.40	Schwarzenbach 2011	Iberian Margin
149_28	6.76	0.60	Schwarzenbach 2011	Iberian Margin
149_29	7.23	0.60	Schwarzenbach 2011	Iberian Margin
149_30	5.7	0.20	Schwarzenbach 2011	Iberian Margin
149_31	3.641	-1.00	Schwarzenbach 2011	Iberian Margin
149_32	4.13	-0.50	Schwarzenbach 2011	Iberian Margin
149_33	3.365	-1.30	Schwarzenbach 2011	Iberian Margin
149_34	5.578	-1.50	Schwarzenbach 2011	Iberian Margin
149_35	0.218	-22.20	Schwarzenbach 2011	Iberian Margin
149_36	0.326	-24.00	Schwarzenbach 2011	Iberian Margin
149_37	0.065	-19.50	Schwarzenbach 2011	Iberian Margin
149_38	0.16	-12.60	Schwarzenbach 2011	Iberian Margin
149_39	0.107	-16.00	Schwarzenbach 2011	Iberian Margin
149_40	0.113	-20.10	Schwarzenbach 2011	Iberian Margin
149_41	0.462	-24.00	Schwarzenbach 2011	Iberian Margin

149_42	0.259	-17.00	Schwarzenbach 2011	Iberian Margin
149_43	0.32	-18.60	Schwarzenbach 2011	Iberian Margin
149_44	0.309	-15.60	Schwarzenbach 2011	Iberian Margin
149_45	0.049	-25.30	Schwarzenbach 2011	Iberian Margin
149_59	0.033	-13.70	Schwarzenbach 2011	Iberian Margin
149_60	0.114	-8.70	Schwarzenbach 2011	Iberian Margin
149_47	0.192	-16.70	Schwarzenbach 2011	Iberian Margin
149_48	0.074	-21.10	Schwarzenbach 2011	Iberian Margin
149_49	0.823	-7.10	Schwarzenbach 2011	Iberian Margin
149_50	0.123	-21.00	Schwarzenbach 2011	Iberian Margin
149_51	0.167	-16.90	Schwarzenbach 2011	Iberian Margin
149_52	0.705	-5.20	Schwarzenbach 2011	Iberian Margin
149_54	0.058	-17.70	Schwarzenbach 2011	Iberian Margin
149_55	0.433	-3.80	Schwarzenbach 2011	Iberian Margin
173_1	0.595	0.70	Schwarzenbach 2011	Iberian Margin
173_2	1.997	1.40	Schwarzenbach 2011	Iberian Margin
173_3	2.93	1.60	Schwarzenbach 2011	Iberian Margin
173_5	0.442	-5.90	Schwarzenbach 2011	Iberian Margin
173_6	0.043	-9.50	Schwarzenbach 2011	Iberian Margin
173_7	0.059	-7.00	Schwarzenbach 2011	Iberian Margin
173_8	0.075	-6.80	Schwarzenbach 2011	Iberian Margin
173_9	0.056	-6.70	Schwarzenbach 2011	Iberian Margin
173_10	0.056	-7.00	Schwarzenbach 2011	Iberian Margin
173_11	0.05	-8.20	Schwarzenbach 2011	Iberian Margin
173_12	0.052	-5.60	Schwarzenbach 2011	Iberian Margin
173_13	0.043	-8.20	Schwarzenbach 2011	Iberian Margin
3863-1301	249	-13.20	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3867-1621	154	-17.70	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3867-1623	175	-13.20	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3872-1136a	197	-16.10	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3873-1300	673	-4.90	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3876-1310	398	-1.90	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3877-1158	242	-8.30	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3877-1307	651	-1.00	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3877-1406	309	-7.20	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3881-1119	61	-22.10	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge

3881-1132A	279	-3.60	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3639-1355		-20.80	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3647-1416	354	-23.00	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3651-1252	482	-20.20	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
H03-R2301	297	-19.70	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
H03-R2243	1750	-0.80	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3873-1245	1306	-0.10	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3638-1029		2.30	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3638-1134	9010	-0.50	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3639-1254S		-5.00	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3646-1409		-9.50	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3650-1146	16,007	0.90	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3650-1436	6510	1.60	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
3652-1203	3533	0.10	Delacour et al 2008	active hydrothermal system - Mid-Atlantic Ridge
AL95-24	799	-13.10	Alt et al 2012	Ultramafic Complex
AL95-26	829	-14.40	Alt et al 2012	Ultramafic Complex
AL95-29	344	-15.80	Alt et al 2012	Ultramafic Complex
AL95-34	363	-12.70	Alt et al 2012	Ultramafic Complex
AL95-41	289	-12.40	Alt et al 2012	Ultramafic Complex
AL95-42	554	-15.30	Alt et al 2012	Ultramafic Complex
AL95-55	436	-12.20	Alt et al 2012	Ultramafic Complex
AL96-01-A	655	-9.60	Alt et al 2012	Ultramafic Complex
AL96-30	753	-10.40	Alt et al 2012	Ultramafic Complex
AL98-23	278	-12.90	Alt et al 2012	Ultramafic Complex
AL95-12	177	-20.20	Alt et al 2012	Ultramafic Complex
AL95-17	845	-11.20	Alt et al 2012	Ultramafic Complex
AL95-35	237	-18.00	Alt et al 2012	Ultramafic Complex
AL96-17	505	-10.60	Alt et al 2012	Ultramafic Complex
AL96-18	537	-9.70	Alt et al 2012	Ultramafic Complex
AL98-03	215	-19.30	Alt et al 2012	Ultramafic Complex
AL98-04-B	311	-20.20	Alt et al 2012	Ultramafic Complex
AL98-05-A	199	-19.30	Alt et al 2012	Ultramafic Complex
AL98-20-A	1276	-10.90	Alt et al 2012	Ultramafic Complex
AL98-33-B	796	-14.10	Alt et al 2012	Ultramafic Complex
LGA1	0.0273	-6.80	Schwarzenbach 2011	Ophiolite
LGA3	0.0198	-10.10	Schwarzenbach 2011	Ophiolite

LGA6 Serp	1.177		Schwarzenbach 2011	Ophiolite
LGA6 Oph	0.795	1.00	Schwarzenbach 2011	Ophiolite
LMO1 Serp	3.25	1.10	Schwarzenbach 2011	Ophiolite
LMO2	0.87	0.60	Schwarzenbach 2011	Ophiolite
LMO6	7.247	1.90	Schwarzenbach 2011	Ophiolite
LMO9-D		-6.50	Schwarzenbach 2011	Ophiolite
LMO13		1.20	Schwarzenbach 2011	Ophiolite
LMO19	0.166	-3.30	Schwarzenbach 2011	Ophiolite
LMO20	0.0418	-12.60	Schwarzenbach 2011	Ophiolite
LMO21	0.0433	-8.70	Schwarzenbach 2011	Ophiolite
LMO22	0.0138	-10.00	Schwarzenbach 2011	Ophiolite
LMO25	0.826	-1.70	Schwarzenbach 2011	Ophiolite
LMO26a	1.13	-1.80	Schwarzenbach 2011	Ophiolite
LPA1	0.0222	-16.40	Schwarzenbach 2011	Ophiolite
LA1	0.038	-8.10	Schwarzenbach 2011	Ophiolite
LA2 Oph-A	0.709	-0.20	Schwarzenbach 2011	Ophiolite
LA2 Oph-B	1.464	0.90	Schwarzenbach 2011	Ophiolite
LA3a	0.798	-0.50	Schwarzenbach 2011	Ophiolite
LA3b	2.345	0.10	Schwarzenbach 2011	Ophiolite
LA4	1.722	1.20	Schwarzenbach 2011	Ophiolite
LA4 Oph	0.914	0.30	Schwarzenbach 2011	Ophiolite
LA5 Oph	1.941	1.10	Schwarzenbach 2011	Ophiolite
LA6 Oph	1.413	1.20	Schwarzenbach 2011	Ophiolite
LA6 Serp-A		-13.00	Schwarzenbach 2011	Ophiolite
LA7Oph	0.414	-0.90	Schwarzenbach 2011	Ophiolite
LA8	0.0269	-6.80	Schwarzenbach 2011	Ophiolite
LA9	0.451	0.10	Schwarzenbach 2011	Ophiolite
LA10	5.878	2.20	Schwarzenbach 2011	Ophiolite
LA12	0.0527	-9.70	Schwarzenbach 2011	Ophiolite
LA14	0.0333	-13.60	Schwarzenbach 2011	Ophiolite
LA15	0.0332	-8.00	Schwarzenbach 2011	Ophiolite
LA16	0.115	-1.80	Schwarzenbach 2011	Ophiolite
LRO1	0.0323	-12.70	Schwarzenbach 2011	Ophiolite
LRO3	0.0289	-12.60	Schwarzenbach 2011	Ophiolite

em

Isotopic results from this study

Natural diamond measurements

NL247-8
NL247-3
Blue1
AB_1
Blue2
NL247-10
110208425476
NL247-19
NL247-15
AB_2
DVBT

Iron borate-doped synthetic diamonds (provided by David Fisher, De Beers Group)

syn107
syn107
syn107
syn107
syn107
syn107
syn271
syn271b
median
median (with rejections)

Biogenic standards

Jcp
Jcp
Jct

Analysis date	B (ppb)	B (ng)	final δ11B (‰)
Sept. 2019	3.52	1.06	-5.19
Sept. 2019	5.30	1.59	-3.23
Sept. 2019	5.89	1.77	-3.08
Nov. 2018	5.84	1.75	-9.24
Nov. 2018	4.08	1.23	-0.47
Feb. 2020	2.67	0.80	-1.65
Feb. 2020	2.33	0.70	-5.35
Feb. 2020	2.61	0.78	-4.77
Feb. 2020	4.12	1.24	-2.43
Feb. 2020	3.07	0.92	-6.57
Feb. 2020	1.77	0.53	-8.23
	3.75	1.12	

Analysis date	δ11B (‰)	2σ (‰)	B (ppb)
10/1/2015	2.63	0.28	n.a.
10/27/2015	2.83	0.28	n.a.
11/15/2018	2.23	0.29	8.89
11/15/2018	2.57	0.30	8.90
9/2/2019	1.83	0.13	37.00
9/2/2019	3.73	0.14	49.00
2/1/2020	2.80	0.30	14.11
2/1/2020	1.23	0.38	9.32
	2.48	1.49	
	2.48	0.77	

Analysis date	δ11B (‰)	2σ (‰)	Documented δ11B and B content
9/1/2018	25.41	0.20	24.3 ‰; 47.7 µg/g B (Farmer et al 2016)
9/1/2018	23.6	0.20	24.3 ‰; 47.7 µg/g B (Farmer et al 2016)
9/1/2018	18.55	0.24	16.68 ‰; 19.4 µg/g B (Farmer et al 2016

final 2σ (‰)	Measured δ11B (‰)	Measured 2σ (‰)	Blank B (ppb)	Blank B (ng)
2.24	-4.45	1.76	0.88	0.26
1.30	-3.06	0.65	0.88	0.26
1.83	-2.95	0.90	0.88	0.26
1.96	-9.06	0.77	0.80	0.24
2.07	-1.94	1.23	0.80	0.24
1.28	-1.65	1.02	0.30	0.09
1.38	-5.35	1.13	0.30	0.09
1.45	-4.77	1.19	0.30	0.09
1.26	-2.43	1.00	0.30	0.09
1.29	-6.57	1.03	0.30	0.09
1.85	-8.23	1.50	0.30	0.09
			0.55	0.16

comments

Data rejected due to extreme graphitization of sample prior to ablation

Data rejected due to damp sample led to vapor phase during ablation

)

Blank δ11B (‰)	Blank 2σ (‰)	Blank corrected 2σ (‰)	Bracketing standard jump (‰)
-2.22	0.72	1.90	-0.90
-2.22	0.72	0.97	-0.38
-2.22	0.72	1.15	-1.20
-7.94	1.34	1.55	-0.92
-7.94	1.34	1.82	-0.62
n.a.	n.a.	1.02	0.14
n.a.	n.a.	1.13	0.15
n.a.	n.a.	1.19	0.29
n.a.	n.a.	1.00	0.01
n.a.	n.a.	1.03	-0.03
n.a.	n.a.	1.50	0.76
-4.51			

Source data of AOC & sediment ranges

	δ11B (‰)	Pressure (GPa)	Reference	Type
DSDP 165 1-1	-1.80	0	Ishikawa and Nakamura (1993)	sediment
DSDP 311 1-2	-6.20	0	Ishikawa and Nakamura (1993)	sediment
DSDP 576 1-1	-4.40	0	Ishikawa and Nakamura (1993)	sediment
KH 75-3 11-2	-3.00	0	Ishikawa and Nakamura (1993)	sediment
DSDP 313 1-5	-3.80	0	Ishikawa and Nakamura (1993)	sediment
DSDP 313 1-5 HCl-soluble	8.00	0	Ishikawa and Nakamura (1993)	sediment
DSDP 313 1-5 HCl-insoluble	-6.60	0	Ishikawa and Nakamura (1993)	sediment
ODP 677A 30-3	4.80	0	Ishikawa and Nakamura (1993)	sediment
ODP 677B 7-4	0.90	0	Ishikawa and Nakamura (1993)	sediment
ODP 677B 7-4 HCl-soluble	10.50	0	Ishikawa and Nakamura (1993)	sediment
ODP 677B 7-4 HCl-insoluble	-1.10	0	Ishikawa and Nakamura (1993)	sediment
GH 82-4 B72	0.30	0	Ishikawa and Nakamura (1993)	sediment
GH 82-4 B72 radiolarians	4.50	0	Ishikawa and Nakamura (1993)	sediment
P617 SC243	-2.20	0	Ishikawa and Nakamura (1993)	sediment
KH 72-2 65	-5.40	0	Ishikawa and Nakamura (1993)	sediment
417A-24	1.6	0	Smith 1995	AOC
417A-32	0.6	0	Smith 1995	AOC
417A-44146	2.4	0	Smith 1995	AOC
417D-22127	-1.7	0	Smith 1995	AOC
417D-39	3.1	0	Smith 1995	AOC
417D-59/60	-2.5	0	Smith 1995	AOC
418A-15	2.3	0	Smith 1995	AOC
418A-40	3.8	0	Smith 1995	AOC
418A-73175	1.2	0	Smith 1995	AOC
418A-86	0.4	0	Smith 1995	AOC
O-100 MF/P	2	0	Smith 1995	AOC
loo-300 MF/P	1.6	0	Smith 1995	AOC
300-550 MF/P	0.5	0	Smith 1995	AOC
O-100 HC/PB	0.3	0	Smith 1995	AOC
10&300 HC/PB	2.66	0	Smith 1995	AOC
30&550 HC/ PB	5.4	0	Smith 1995	AOC
B	-2.2	0	Smith 1995	AOC
C	5	0	Smith 1995	AOC

I	5.9	0	Smith 1995	AOC
J	2.7	0	Smith 1995	AOC
K	8.4	0	Smith 1995	AOC
L	-1.7	0	Smith 1995	AOC
M	-4.3	0	Smith 1995	AOC
O	7.6	0	Smith 1995	AOC
P	24.9	0	Smith 1995	AOC
Q	19.2	0	Smith 1995	AOC
T	11.4	0	Smith 1995	AOC
V	11.3	0	Smith 1995	AOC
min	-6.60			
max	24.90			

Source data for $\delta^{11}B$ of carbonatites unaffected by contamination

Sample	mean d11B	Reference
13-2	1.13	Hulett et al. 2016
AMD-003	4.80	Hulett et al. 2016
BMR 056	-3.06	Hulett et al. 2016
MC117	1.51	Hulett et al. 2016
TAN 213	1.24	Hulett et al. 2016
OKA 4A	-2.23	Hulett et al. 2016
OKA 4B	1.03	Hulett et al. 2016
OKA 206	1.45	Hulett et al. 2016
OKA 203	0.68	Hulett et al. 2016
OKA 109	-3.02	Hulett et al. 2016
OKA 153	-0.88	Hulett et al. 2016
13-19	-6.33	Hulett et al. 2016
13-6	1.47	Hulett et al. 2016
13-1	-5.24	Hulett et al. 2016
13-29	-0.27	Hulett et al. 2016
13-27	-7.95	Hulett et al. 2016
13-11	-5.98	Hulett et al. 2016
MB-3a	-3.33	Çimen et al. 2018
MB-3b	-6.65	Çimen et al. 2018
MB-4B	-6.26	Çimen et al. 2018
MB-6	2.82	Çimen et al. 2018
MB-7	-7.34	Çimen et al. 2018
MB-8	3.89	Çimen et al. 2018
FIR-W	-3.98	Çimen et al. 2019
FIR-K	-2.47	Çimen et al. 2019
GUM	-8.67	Çimen et al. 2019
HW-CR	-6.36	Çimen et al. 2019
FLX	-8.38	Çimen et al. 2019
FEN-1	-7.12	Çimen et al. 2019
FEN-2	-9.79	Çimen et al. 2019
CHP-LK	-8.48	Çimen et al. 2019
1559	-6.2	Kuebler et al. 2020
1729B	-7.8	Kuebler et al. 2020
1649.5	-7.9	Kuebler et al. 2020
1666	-9	Kuebler et al. 2020
1666B	-3.6	Kuebler et al. 2020
1679	-7.6	Kuebler et al. 2020
1679B	-8.6	Kuebler et al. 2020
1551.6	-5.2	Kuebler et al. 2020

Source data for δ^{11}B of OIB unaffected by contamination and fractional crystallization (Marschall 2018)

Sample	δ11B	Locality	Reference
PL2-RC-01	-10.60	Galapagos Island	Chaussidon and Marty 1995
PL2-24-14	-9.80	Galapagos Island	Chaussidon and Marty 1995
PL2-24-32	-10.00	Galapagos Island	Chaussidon and Marty 1995
PL2-25-03	-8.20	Galapagos Island	Chaussidon and Marty 1995
PL2-29-03	-10.10	Galapagos Island	Chaussidon and Marty 1995
PL2-9-29	-6.60	Galapagos Island	Chaussidon and Marty 1995
PL2-14-8	-11.40	Galapagos Island	Chaussidon and Marty 1995
PL2-26-7	-10.60	Galapagos Island	Chaussidon and Marty 1995
SO84-63DS-1	-11.10	St. Helene island	Chaussidon and Marty 1995
SO84-63DS-2	-9.40	St. Helene island	Chaussidon and Marty 1995
SO84-63DS-3	-11.60	St. Helene island	Chaussidon and Marty 1995
SO84-63DS-4	-9.80	St. Helene island	Chaussidon and Marty 1995
SO47-64DS-2	-9.00	McDonald seamount	Chaussidon and Marty 1995
HW1	-4.00	Hawai'i	Tanaka and Nakamura 2005
HW2	-3.90	Hawai'i	Tanaka and Nakamura 2005
HW24	-3.70	Hawai'i	Tanaka and Nakamura 2005
HW21	-4.10	Hawai'i	Tanaka and Nakamura 2005
HW6	-3.70	Hawai'i	Tanaka and Nakamura 2005
HW22	-3.60	Hawai'i	Tanaka and Nakamura 2005
HW27	-4.20	Hawai'i	Tanaka and Nakamura 2005
HW7-3	-3.80	Hawai'i	Tanaka and Nakamura 2005
HW29	-3.70	Hawai'i	Tanaka and Nakamura 2005
HW9	-4.60	Hawai'i	Tanaka and Nakamura 2005
HW11-2	-4.30	Hawai'i	Tanaka and Nakamura 2005
HW30	-3.30	Hawai'i	Tanaka and Nakamura 2005
HW35	-3.40	Hawai'i	Tanaka and Nakamura 2005
HW34	-3.00	Hawai'i	Tanaka and Nakamura 2005
HW33	-3.10	Hawai'i	Tanaka and Nakamura 2005
HW32	-3.50	Hawai'i	Tanaka and Nakamura 2005
HW31	-3.80	Hawai'i	Tanaka and Nakamura 2005
WAF-2	-5.30	Hawai'i	Tanaka and Nakamura 2005
KOL43	-5.00	Hawai'i	Tanaka and Nakamura 2005
KOL48	-5.20	Hawai'i	Tanaka and Nakamura 2005

K89-6	-5.20	Hawai'i	Tanaka and Nakamura 2005
D7-1	-5.40	Hawai'i	Tanaka and Nakamura 2005
S500-1	-5.40	Hawai'i	Tanaka and Nakamura 2005
S500-5B	-4.50	Hawai'i	Tanaka and Nakamura 2005
S500-9A	-5.00	Hawai'i	Tanaka and Nakamura 2005
WAF-36	-5.90	Hawai'i	Tanaka and Nakamura 2005
WAF-39	-5.00	Hawai'i	Tanaka and Nakamura 2005
KOL14	-4.20	Hawai'i	Tanaka and Nakamura 2005
MH-11	-1.80	Hawai'i	Tanaka and Nakamura 2005
PM1	0.90	Hawai'i	Tanaka and Nakamura 2005
PM7	-0.30	Hawai'i	Tanaka and Nakamura 2005
LK1	-2.50	Hawai'i	Tanaka and Nakamura 2005
LK2	-3.60	Hawai'i	Tanaka and Nakamura 2005
LK3	-2.80	Hawai'i	Tanaka and Nakamura 2005
LK4	-2.20	Hawai'i	Tanaka and Nakamura 2005
KH85-DE36069	-9.30	Hawai'i	Chaussidon and Marty 1995
KH85-DE36061	-10.60	Hawai'i	Chaussidon and Marty 1995
37_LP-1017-MI03_x-613y-546	-10.00	Canary Islands	Walowski et al. 2019
38_LP-1017-MI01_x3630y1028	-9.80	Canary Islands	Walowski et al. 2019
39_LP-1017-MI09_x509y-2318	-13.69	Canary Islands	Walowski et al. 2019
40_LP-1017-MI16_x618y-3576	-11.17	Canary Islands	Walowski et al. 2019
44_LP-1017-MI20_x573y-5935	-6.66	Canary Islands	Walowski et al. 2019
61_LP-1017-MI04_x-2809y-542	-11.10	Canary Islands	Walowski et al. 2019
60_LP-1017-MI01-02enc_x3199y844	-9.60	Canary Islands	Walowski et al. 2019
36_LP-1017_MI06a_x5642y-1881	-8.89	Canary Islands	Walowski et al. 2019
37_LP-1017_MI06b_x5505y-1828	-11.28	Canary Islands	Walowski et al. 2019
38_LP-1017_MI13_x4613y-4383	-9.38	Canary Islands	Walowski et al. 2019
39_LP-1017_MI_18_x-2003y-4520	-9.17	Canary Islands	Walowski et al. 2019
42_LP-1017_MI_01re_x3535y922	-7.55	Canary Islands	Walowski et al. 2019
48_LP-1002-MI02_x58y5015	-9.10	Canary Islands	Walowski et al. 2019
54_LP-1002-MI09_x-2128y7402	-10.31	Canary Islands	Walowski et al. 2019
57_LP-1002_MI08_x-3027y6921	-10.88	Canary Islands	Walowski et al. 2019
60_LP-1002-MI14_x-4908y4569	-10.57	Canary Islands	Walowski et al. 2019
61_LP-1002-MI17_x-4431y1075	-8.64	Canary Islands	Walowski et al. 2019
62_LP-1002-MI22_x-6434y4260	-12.36	Canary Islands	Walowski et al. 2019
34_LP_1002_MI201_x-230y316	-10.30	Canary Islands	Walowski et al. 2019

37_LP_1002_MI206_x-1719y-2689	-11.15	Canary Islands	Walowski et al. 2019
40_LP_1002_MI207b_x-1846y-4540	-10.85	Canary Islands	Walowski et al. 2019
41_LP_1002_MI210_x-3513y-3465	-11.32	Canary Islands	Walowski et al. 2019
39_LP_1006_06_x-102y-2314	-9.05	Canary Islands	Walowski et al. 2019
40_LP_1006_05_x748y-5345	-8.09	Canary Islands	Walowski et al. 2019
48_LP_1006_05b_x671y-5918	-7.03	Canary Islands	Walowski et al. 2019
50_LP_1006_07_x-1335y-3589	-8.36	Canary Islands	Walowski et al. 2019
51_LP_1006_09_x-896y-6100	-8.46	Canary Islands	Walowski et al. 2019
41_LP_1025_10_x-274y3102	-8.53	Canary Islands	Walowski et al. 2019
57_LP_1025_01_x3570y1435	-12.00	Canary Islands	Walowski et al. 2019
61_LP_1025_05_x1608y5279	-9.04	Canary Islands	Walowski et al. 2019
63_LP_1025_08a_x-1784y6154	-10.86	Canary Islands	Walowski et al. 2019
67_LP_1025_13_x-1230y2799	-9.23	Canary Islands	Walowski et al. 2019
68_LP_1025_11_x-3177y6163	-7.99	Canary Islands	Walowski et al. 2019
69_LP_1025_17_x-3815y193	-12.48	Canary Islands	Walowski et al. 2019
70_LP_1025_15_x-3748y2692	-13.26	Canary Islands	Walowski et al. 2019
42_LP_1025_MI201_x-1429y2460	-13.45	Canary Islands	Walowski et al. 2019
45_LP_1025_MI202_x-2510y3161	-9.05	Canary Islands	Walowski et al. 2019
46_LP_1025_MI208a_x-1190y3942	-7.86	Canary Islands	Walowski et al. 2019
47_LP_1025_MI208b_x-1188y4175	-10.57	Canary Islands	Walowski et al. 2019
48_LP_1025_MI203_x-4501y2610	-9.09	Canary Islands	Walowski et al. 2019
50_LP_1025_MI209_x-1141y5944	-11.53	Canary Islands	Walowski et al. 2019
51_LP_1025_MI209bre_x-1445y7320	-10.10	Canary Islands	Walowski et al. 2019
52_LP_1025_MI210a_x-3022y6436	-9.19	Canary Islands	Walowski et al. 2019
53_LP_1025_MI210b_x-4293y6524	-10.41	Canary Islands	Walowski et al. 2019
35_LP_1025_MI301_x3599y-2183	-8.44	Canary Islands	Walowski et al. 2019
37_LP_1025_MI302_x3244y-785	-10.63	Canary Islands	Walowski et al. 2019
38_LP_1025_MI305a_x3769y3067	-7.66	Canary Islands	Walowski et al. 2019
39_LP_1025_MI305b_x3587y3595	-8.06	Canary Islands	Walowski et al. 2019
40_LP_1025_MI306_x5728y1767	-10.58	Canary Islands	Walowski et al. 2019
5_RPC_01_x2584y761.ais	-6.56	La reunion	Walowski et al. 2019
6_RPC_02_x3792y1069.ais	-7.00	La reunion	Walowski et al. 2019
7_RPC_03_x5322y1068.ais	-7.75	La reunion	Walowski et al. 2019
8_RPC_06_x-2354y1643@1.ais	-8.29	La reunion	Walowski et al. 2019
9_RPC_07_x-3618y1568@2.ais	-6.80	La reunion	Walowski et al. 2019
11_RPC_08_x-5283y1260@4.ais	-7.96	La reunion	Walowski et al. 2019

12_RPC_15_x-5530y-1738@5.ais	-6.48	La reunion	Walowski et al. 2019
13_RPC_16_x-4212y-1426@6.ais	-6.39	La reunion	Walowski et al. 2019
14_RPC_19_x640y-2513@7.ais	-7.55	La reunion	Walowski et al. 2019
15_RPCC_20_x4138y-1955@8.ais	-6.52	La reunion	Walowski et al. 2019
19_RPC_23_1_x-2408y-4381.ais	-8.65	La reunion	Walowski et al. 2019
20_RPC_24_x1747y-4042.ais	-5.84	La reunion	Walowski et al. 2019
21_RPC_27_x4613y-5850.ais	-8.04	La reunion	Walowski et al. 2019
22_RPC_28_x1234y-6570.ais	-6.88	La reunion	Walowski et al. 2019
23_RPC_29_x-1723y-6534.ais	-7.80	La reunion	Walowski et al. 2019
71_RPC_113_x-2753y5623	-10.50	La reunion	Walowski et al. 2019
72_RPC_113_2_x-2413y5602	-8.92	La reunion	Walowski et al. 2019
73_RPC_112_x-798y5927	-8.23	La reunion	Walowski et al. 2019
74_RPC_112__2x-932y6177	-10.46	La reunion	Walowski et al. 2019
75_RPC_108_x4267y3025	-7.64	La reunion	Walowski et al. 2019
77_RPC_107_x2364y3836	-9.11	La reunion	Walowski et al. 2019
78_RPC_111_x402y5472	-10.62	La reunion	Walowski et al. 2019

Results of trace element analyses of silica glass ablation windows. <LOD indicates bel

Sample name	TPB_1	TPB_2	TPB_3	Rinse_4
Window quality	n.a.	n.a.	n.a.	scratches
Experiment	blank	blank	blank	rinse of polished face
Sr (ppb)	<LOD	4.18	<LOD	<LOD
2σ abs.	<LOD	11.52	<LOD	<LOD
Zr (ppb)	5.8	<LOD	<LOD	<LOD
2σ abs.	6.1	<LOD	<LOD	<LOD
La (ppb)	<LOD	0.001	<LOD	0.052
2σ abs.	<LOD	0.236	<LOD	0.211
Ce (ppb)	0.46	<LOD	<LOD	0.72
2σ abs.	0.12	<LOD	<LOD	0.11
Pr (ppb)	0.004	<LOD	<LOD	0.001
2σ abs.	0.017	<LOD	<LOD	0.018
Eu (ppb)	<LOD	<LOD	<LOD	<LOD
2σ abs.	<LOD	<LOD	<LOD	<LOD
Ho (ppb)	0.00	<LOD	<LOD	<LOD
2σ abs.	0.01	<LOD	<LOD	<LOD
Er (ppb)	0.01	<LOD	<LOD	<LOD
2σ abs.	0.01	<LOD	<LOD	<LOD
Lu (ppb)	0.00	<LOD	<LOD	<LOD
2σ abs.	0.00	<LOD	<LOD	<LOD
Hf (ppb)	0.26	<LOD	<LOD	<LOD
2σ abs.	0.20	<LOD	<LOD	<LOD
CeN/LaN	<LOD	<LOD	<LOD	<LOD

ow limit of detection (blank + 3σ) and red font indicates below lin

Rinse_7	10_1
laser damage	no scratches
rinse of polished face	10 min soak of polished face
<LOD	<LOD
<LOD	<LOD
3.52	<LOD
6.28	<LOD
<LOD	<LOD
<LOD	<LOD
0.36	0.59
0.15	0.07
0.014	<LOD
0.025	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
0.00	<LOD
0.00	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD

nit of quantification (LOQ = blank + 7σ).

10_2	20_1
no scratches	no scratches
10 min soak of polished face	20 min soak of polished face
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	0.013
<LOD	0.093
0.20	1.2
0.061	0.098
<LOD	0.005
<LOD	0.008
<LOD	<LOD
<LOD	<LOD
<LOD	0.00
<LOD	0.00
<LOD	<LOD
<LOD	<LOD
<LOD	0.00
<LOD	0.00
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD

20_2	10_3
no scratches	laser damage
20 min soak of polished face	10 min soak of unpolished face
2.42	<LOD
4.92	<LOD
<LOD	<LOD
<LOD	<LOD
0.024	0.28
0.125	0.047
0.29	2.7
0.070	0.15
0.008	0.0090
0.011	0.0036
<LOD	<LOD
<LOD	<LOD
0.0017	<LOD
0.0023	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	0.00
<LOD	0.00
<LOD	<LOD
<LOD	<LOD
<LOD	3.7

10_5	20_6
no scratches	scratched & damanged
10 min soak of unpolished face	20 min soak of unpolished face
<LOD	23
<LOD	2.4
<LOD	21
<LOD	2.2
0.31	1.4
0.04	0.12
4.9	7.52
0.35	0.61
0.029	0.22
0.0047	0.018
<LOD	0.051
<LOD	0.033
<LOD	0.014
<LOD	0.0019
0.00	0.042
0.00	0.0043
0.00	0.0070
0.00	0.0015
<LOD	0.58
<LOD	0.058
6.0	2.1

ave unpolished face	ave polished face
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
0.31	<LOD
0.047	<LOD
4.9	0.48
0.35	0.086
0.029	<LOD
0.0047	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
<LOD	<LOD
3.7	<LOD