

Supplementary Materials for **The growth of lithospheric diamonds**

Hélène Bureau, Laurent Remusat, Imène Esteve, Daniele L. Pinti, Pierre Cartigny

Published 6 June 2018, *Sci. Adv.* **4**, eaat1602 (2018)

DOI: 10.1126/sciadv.aat1602

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table S1. Isotopic compositions of the starting materials, standards, and samples. The isotopic compositions of the starting materials were analyzed by gas source mass spectrometry when the samples were measured by NanoSIMS.

Name	Sample description	$\delta^{13}\text{C}$ (uncertainty)
Starting Materials		
MELD	Powder of oxides and carbonates ¹	-11.40 ± 0.1‰ *
MELD SID	Powder MELD + SIDERITE ²	-11.38 ± 0.1‰ *
CaCO ₃ ****	Commercial Synthetic powder	-6.65 ± 0.1‰ *
Na ₂ CO ₃ ****	Commercial Synthetic powder	-4.75 ± 0.1‰ *
K ₂ CO ₃ ****	Commercial Synthetic powder	-16.17 ± 0.1‰ *
(Fe,Mg)CO ₃ *****	Natural Siderite ³	-7.60 ± 0.1‰ *
Graphite	Pure graphite powder	-26.35 ± 0.1‰ *
Diamond seeds	Powder MSY 20-30µm from Microdiamant	-30.43 ± 1.35‰ **
Diamond seeds	Powder MSY 20-30µm from Microdiamant	-29.60 ± 1.36‰ **
Standards		
NIa	Natural diamond Ia	-3.6 ± 0.1‰ ***
SIIa	Synthetic diamond IIa	-20.9 ± 0.1‰ ***
Samples*****		
HBD01	HBD01-1 TM	-26.33 ± 1.57‰ ***
HBD01	HBD01-2 TM	-27.68 ± 1.46‰ ***
HBD01	HBD01-3 TM	-24.53 ± 1.46‰ ***
H3908	H3908-1 TM	-20.22 ± 1.66‰ ***
H3908	H3908-3 TM	-20.66 ± 1.61‰ ***
H3908	H3908-4 TM	-18.56 ± 1.57‰ ***
H3908	H3908-AREA 2, A: diamond inclusions	-14.19 ± 3.16‰ ***
H3913	piece of diamond H3913-AREA3 A	-24.46 ± 2.49‰ ***
H3913	piece of diamond H3913-AREA3 C	-20.26 ± 3.00‰ ***
H3913	piece of diamond H3913-AREA3 B	-17.93 ± 4.41‰ ***
H3913	piece of diamond H3913-AREA 2 A	-27.84 ± 3.13‰ ***
H3913	H3913-1 TM	-20.98 ± 2.55‰ ***

¹ MELD: SiO₂+Al₂O₃+MgO+CaCO₃+Na₂CO₃+K₂CO₃+TiO₂ after (8)

² 90 wt.% of synthetic powder MELD + 10 wt.% of Natural Siderite SIDB after (9)

TM total Map; A, B, C selected areas of interest

*Gas source mass spectrometry analysis performed at GEOTOP, UQAM, Montréal

** NanoSIMS analysis after QSA corrections (33)

***Gas source mass spectrometry analysis performed at IPGP, Paris.

**** mixed in MELD and in MELD SID

*****Maps of 5x5 µm²; D diamond ; TM total map ; ROI Region of interest selected in the map

table S2. Description of the studied samples.

Sample	Starting composition	Pressure	Temperature	Duration	Size of growth	Minerals in Inclusions
HBD01*	50% MELD*** + 50% H ₂ O + G + D	7 GPa	1675°C	1:30 hrs	Up to 10 μm	phengite + coesite + (CaMg)CO ₃
H3908**	50% MELD + 50% H ₂ O- NaCl(10 g/l) + G + D	7 GPa	1400°C	6:00 hrs	8-10 μm	D + phengite + (CaMg)CO ₃ + coesite + rutile
H3913**	50 % MELD SID**** + 50 % H ₂ O- NaCl(30 g/l) + G + D	7 GPa	1400°C	6:00 hrs	4-5 μm	D + olivine + (CaMg)CO ₃

*from (8);

** from (9); D diamond; the sizes of growth are measured from a few FIB preparations and should be taken as orders of magnitude; minerals trapped as inclusions in diamonds are also present in the solid matrix.

*** The starting composition “MELD” was derived from the average oxide/carbonate contents of inclusions trapped in metasomatic diamonds (Navon et al., 1988). It was prepared by mixing pure synthetic powders of SiO₂, Al₂O₃, MgO, CaCO₃, Na₂CO₃, K₂CO₃ and TiO₂, iron oxide was replaced by magnesium oxide, resulting in the following composition in wt.%: SiO₂ 40.47; Al₂O₃ 4.36; MgO 21.07; CaO 9.29; Na₂O 2.36; K₂O = 17.57; TiO₂ 4.89; plus about 15 wt.% of CO₂.

**** MELD SID: is a mixture of 90% MELD with 10% natural (Fe,Mg)CO₃, resulting in the following composition in wt.%: SiO₂ 37.96; Al₂O₃ 4.09; MgO 20.02; CaO 8.80; Na₂O 2.21; K₂O = 16.48; TiO₂ 4.59; FeO 5.12; MnO 0.75; about 17.5 wt.% of CO₂.

table S3. Mass balance calculations of isotopic compositions of the bulk composition for the starting materials and the high-pressure and high-temperature carbonate fluid.

$\delta^{13}\text{C}_{\text{bulk}} = x \delta^{13}\text{C}_{\text{carbonatepowder}} + y\delta^{13}\text{C}_{\text{graphite}}$, where x, y are weight fractions of both components loaded in the Pt capsules for each experiment, x+y=1, powders are MELD or MELD SID. Uncertainties are calculated from the quadratic sum of analytical errors

Sample	$\delta^{13}\text{C}$ Bulk isotopic composition All carbonates + graphite*	Whole range of $\delta^{13}\text{C}$ compositions of the samples including contaminations from the seeds, new diamond areas and inclusions
HBD01	$-15.14 \pm 0.14\text{‰}$	-27.68 ± 1.46 to $-24.53 \pm 1.46\text{‰}$
H3908	$-16.95 \pm 0.14\text{‰}$	-20.66 ± 1.61 to $-14.19 \pm 3.16\text{‰}$
H3913	$-15.49 \pm 0.14\text{‰}$	-27.84 ± 3.13 to $-17.93 \pm 4.41\text{‰}$

*Calculated following the mass balance:

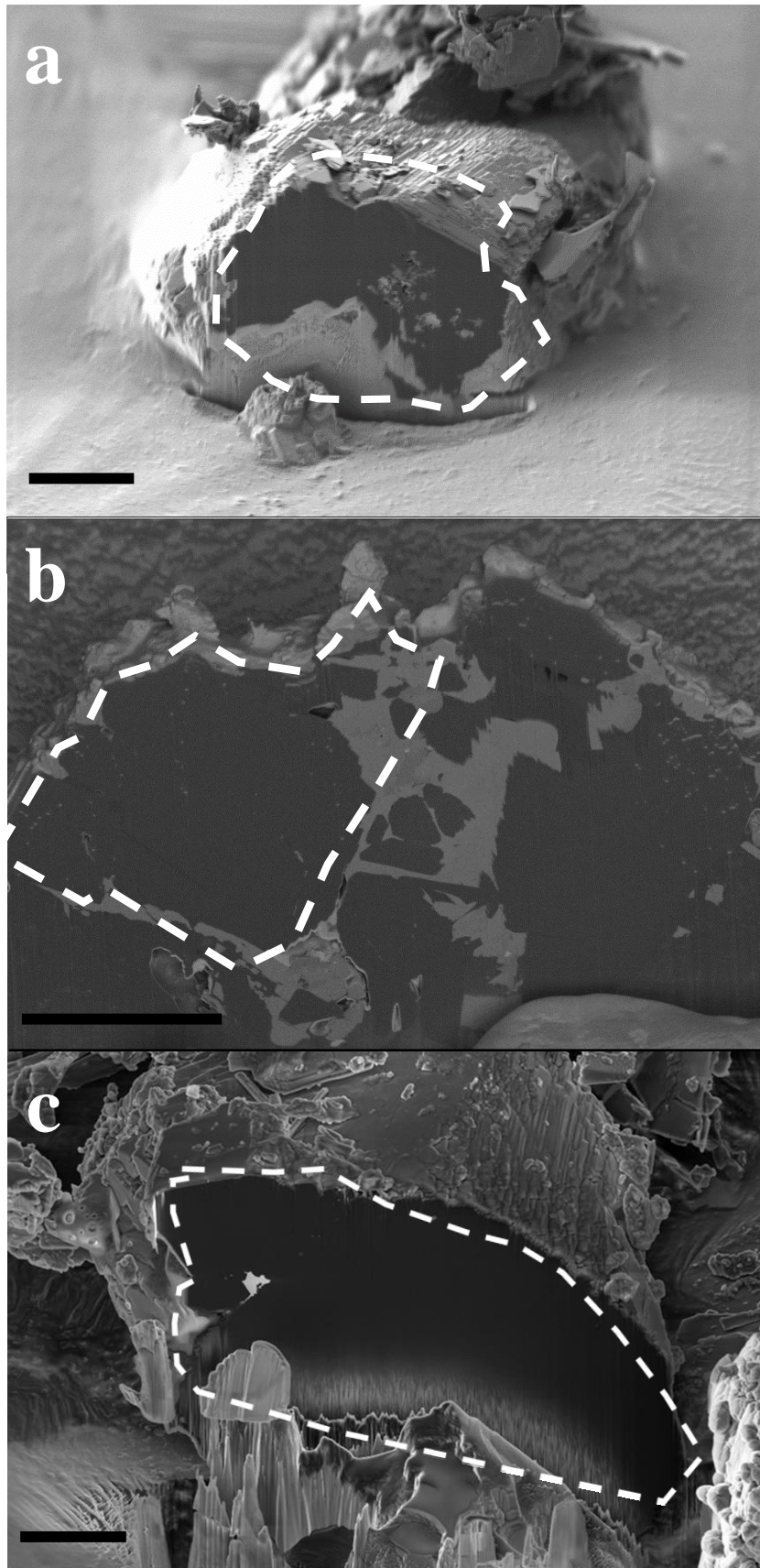


fig. S1. SEM images of the FIB preparation, cut on one side of the seed and on the other side to obtain the final slices. White dotted lines represent the final slices. Bar scale is 10 μ m. a: H3908, b: H3913, note that the other face was analyzed, c: HBD01.

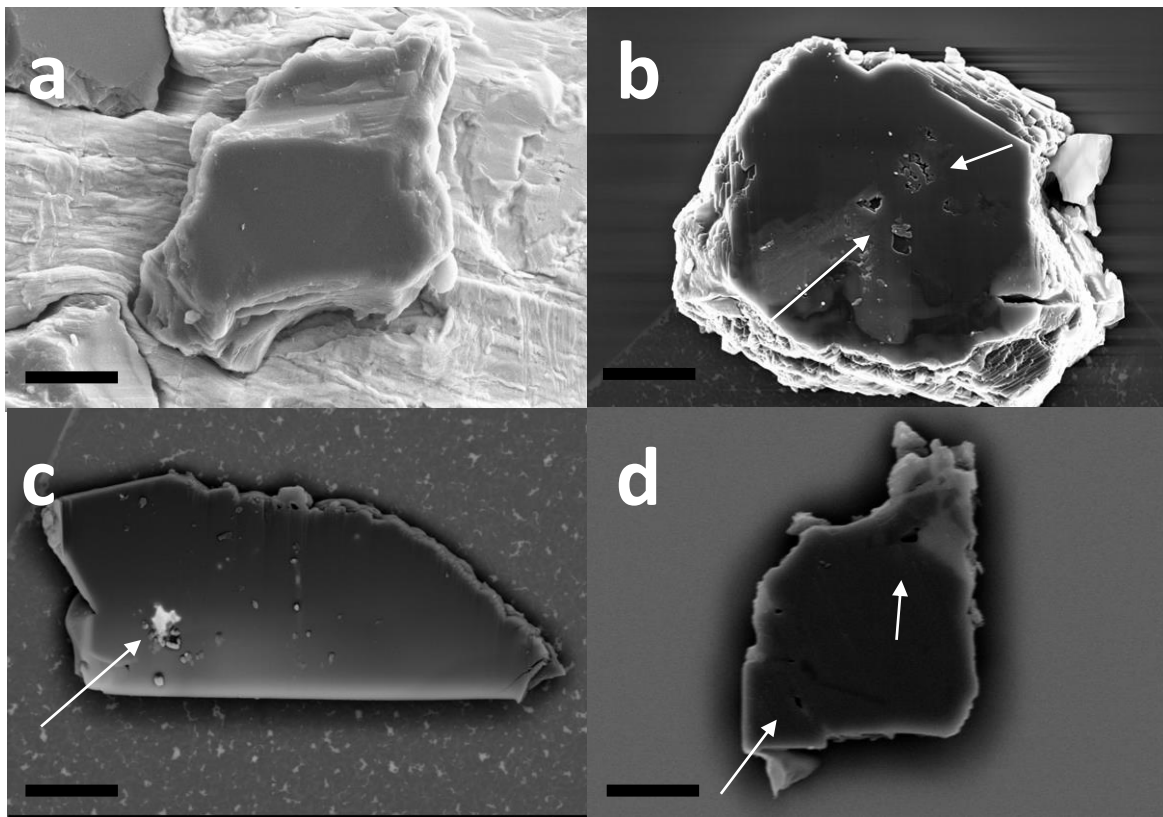


fig. S2. Details of the samples analyzed with the NanoSIMS. A. initial diamond seed in Indium plate. FIB thick foils of sample B. H3908, C. HBD01, D. H3913 are placed on silicon wafers. Arrows indicate the position of inclusions trapped during the growth. Bar scale is 10 μm .

NanoSIMS ^{12}C images

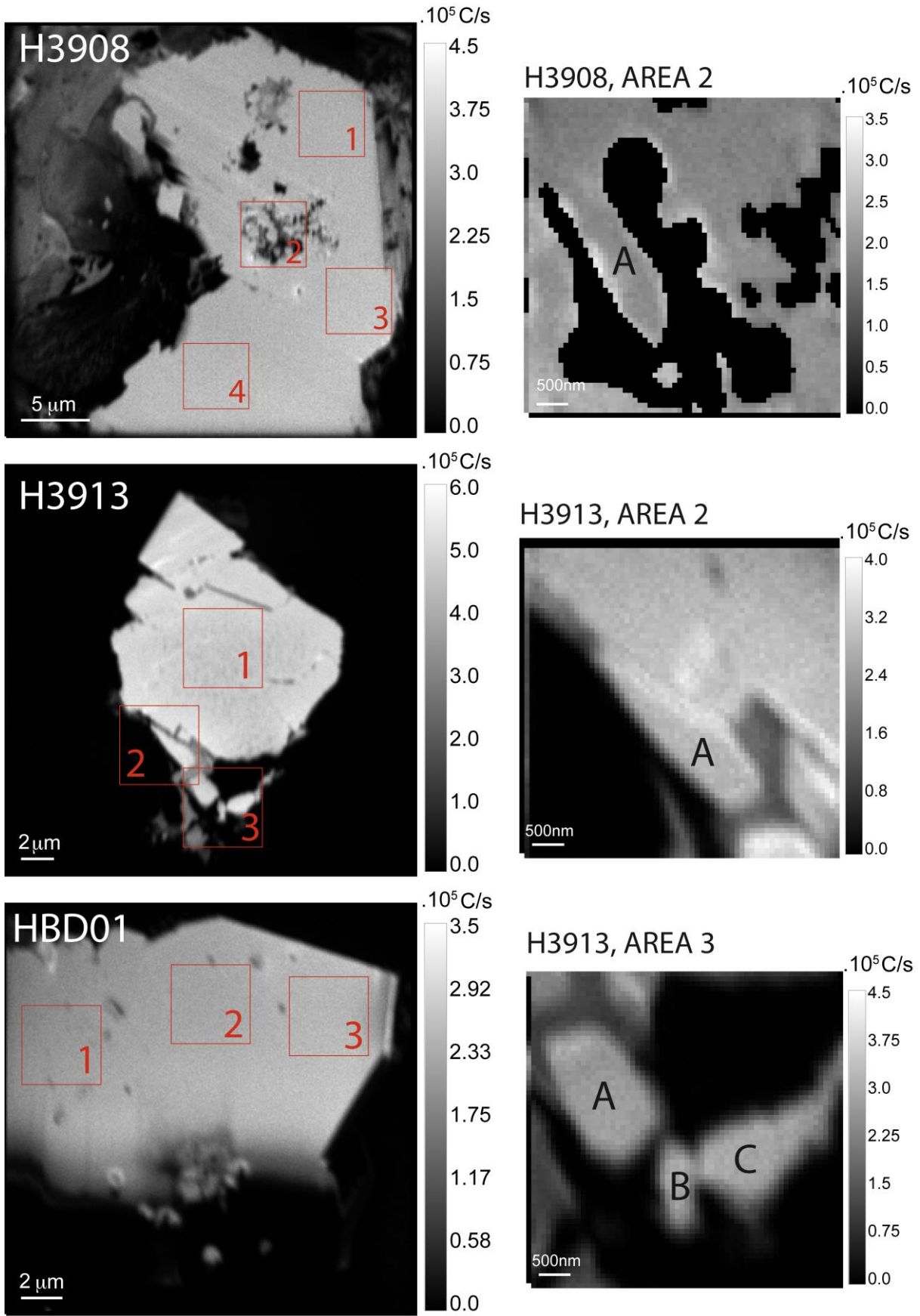


fig. S3. NanoSIMS maps of ^{12}C for each investigated sample showing the locations of the areas of interest (red squares) corresponding to the location of the measurements reported in table S1 and Fig. 1. In some cases, the diamond fragments are smaller than the typical size of areas of interests ($5 \times 5 \mu\text{m}$), and only material corresponding to diamond was selected. In the area 2 of sample H3908, only the selected area A corresponds to the diamond inclusion. Details of the areas 2 and 3 of sample H3913 are shown: area 2 contains 1 diamond fragment, called H3913-AREA2 A in table S1, and area 3 contains 3 fragments, possibly new diamond crystals, called H3913-AREA3 A, B and C in table S1.