

Enstatite chondrites EL3 as building blocks for the Earth: the debate 1 over the 146 Sm-142 Nd systematics

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1	Enstatite chondrites EL3 as building blocks for the Earth: the debate
2	over the ¹⁴⁶ Sm- ¹⁴² Nd systematics
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14	building blocks
15	
16	Abstract
17	The ¹⁴⁶ Sm- ¹⁴² Nd extinct decay scheme (¹⁴⁶ Sm half-life of 103 My) is a powerful tool
18	to trace early Earth silicate differentiation. Differences in ¹⁴² Nd abundance measured
19	between different chondrite meteorite groups and the modern Earth challenges the
20	interpretation of the ¹⁴² Nd isotopic variations found in terrestrial samples because the
21	origin of the Earth and the nature of its building blocks is still an ongoing debate. As
22	bulk meteorites, the enstatite chondrites (EC) have isotope signatures that are the
23	closest to the Earth value with an average small deficit of ~ 10 ppm in ¹⁴² Nd relative
24	to modern terrestrial samples. Here we review all the Nd isotope data measured on EC
25	so far, and present the first measurements on an observed meteorite fall Almahata

26 Sitta containing pristine fragments of an unmetamorphosed enstatite chondrite belonging to the EL3 subgroup. Once ¹⁴²Nd/¹⁴⁴Nd ratios are normalized to a common 27 chondritic evolution, samples from the EC group (both EL and EH) have a deficit in 28 ¹⁴²Nd but the dispersion is important (μ^{142} Nd= -10 ± 12 (2SD) ppm). This scatter 29 30 reflects their unique mineralogy associated to their formation in reduced conditions 31 (low fO₂ or high C/O). Rare-earth elements are mainly carried by the sulfide phase 32 oldhamite (CaS) that is more easily altered than silicates by weathering since most of 33 the EC meteorites are desert finds. The EL6 have fractionated rare-earth element 34 patterns with depletion in the most incompatible elements. Deviations in Nd mass 35 independent stable isotope ratios in enstatite chondrites relative to terrestrial standard 36 are not resolved with the level of analytical precision achieved by modern mass 37 spectrometry techniques. Here we show that enstatite chondrites from the EL3 and 38 EL6 subgroups may come from different parent bodies. Samples from the EL3 subgroup have Nd (μ^{142} Nd= -0.8 ± 7.0, 2SD) and Ru isotope ratios undistinguishable 39 from that of the Bulk Silicate Earth. EL3 samples have never been analyzed for Mo 40 41 isotopes. Because these enstatite chondrites are relatively small in size and number, 42 they are usually not available for destructive isotopic measurements. Average values 43 based on the measurement of EL6 samples should not be considered as representative 44 of the whole EL group because of melting and thermal metamorphism events 45 affecting the Sm/Nd ratios and prolonged open-system history. The EL3 chondrites 46 are the best candidates as the Earth's building blocks. These new results remove the 47 need to change the composition of refractory incompatible elements early in Earth's 48 history.

49

50 1. Introduction

52 Variations in mass independent stable isotope ratios, also called nucleosynthetic 53 anomalies, of refractory elements have become extremely useful to trace the origin of 54 the different planetary bodies and their relative contribution into the building process 55 of terrestrial planets (e.g., Warren, 2011). Enstatite chondrites appear to be the closest 56 in isotope composition to terrestrial samples and carbonaceous chondrites the furthest. 57 Enstatite chondrites and the Earth are undistinguishable for many isotope systems, i.e. Cr, Ti, O, Ni (see Dauphas, 2017 for a recent review), meaning that with the current 58 59 level of precision no resolvable difference is observed between both materials. A 60 small difference in Si isotopes does exist and this has been used against the Enstatite 61 Chondrite Earth model (Fitoussi and Bourdon, 2012) but Si isotopes may have been 62 fractionated during nebular processes and their isotope ratios may not faithfully 63 reflect the initial composition of the starting material (Savage and Moynier, 2013; 64 Zambardi et al., 2013; Dauphas et al., 2015). The only resolvable differences between 65 enstatite chondrites and the Earth were reported for Mo and Ru isotope compositions 66 (Burkhardt et al., 2011; Fischer-Gödde and Kleine 2017). The enrichment in s-process 67 Mo for the Earth relative to chondrites suggests that the composition of the Earth 68 cannot be reconstructed by any known combination of meteorites because it is itself 69 an end-member in the mixing trend (Burkhardt et al., 2011). The initial composition of the Earth has become an issue for the use and interpretation of the ¹⁴⁶Sm-¹⁴²Nd 70 71 short-lived isotopic systematic in meteorites and Earth rocks. An early fractionation of the Sm/Nd ratio during the lifetime of 146 Sm (T_{1/2}=103 Ma) would modify the 72 ¹⁴²Nd/¹⁴⁴Nd signatures by radiogenic production. In 2005, the first high-precision 73 74 ¹⁴²Nd measurements in chondrites revealed a difference of about 20 ppm with the 75 modern terrestrial samples (Boyet and Carlson, 2005). Because both Sm and Nd are

76 lithophile elements under terrestrial redox conditions (Bouhifd et al., 2015), a 77 differentiation event of the silicate Earth in the first 30 Ma of Solar System history 78 has been proposed to explain this offset. One type of model considers that the bulk 79 Silicate Earth (BSE) preserves a relative chondritic abundance of refractory lithophile 80 elements. The early-depleted mantle reservoir (high Sm/Nd) served as the source for 81 magmatism since its formation whereas the enriched reservoir remains isolated from 82 mantle convection and is still untapped (Boyet and Carlson, 2005). Other scenarios 83 proposed that the complementary enriched reservoir (low Sm/Nd) has been lost to 84 space by collisional erosion of planetesimals (Caro et al., 2008; O'Neill and Palme, 85 2008) leaving the Bulk Earth depleted in incompatible elements and with a higher 86 Sm/Nd ratio relative to the well-constrained average composition of whole-rock chondrites from the carbonaceous (CC), ordinary (OC) and enstatite (EC) chondrite 87 88 groups (Bouvier et al., 2008).

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90 These models have been challenged by the discovery of variations in mass 91 independent stable Sm and Nd isotope ratios in whole-rock chondrites and their 92 components (Andreasen and Sharma, 2006; Carlson et al., 2007; Gannoun et al., 93 2011; Brennecka et al., 2013, Bouvier and Boyet, 2016; Burkhardt et al., 2016). The isotope ¹⁴²Nd is mainly produced by *s*-process but has a small contribution of p-94 95 process, estimated to be lower than a few percent (Arlandini et al., 1999; Bisterzo et al., 2011). The parent isotope, ¹⁴⁶Sm is a pure *p*-process nuclide so any variation in 96 the p production would affect the abundance of its daughter isotope 142 Nd as well. 97 98 Although we have undisputable evidences for different contribution of s-process isotopes in Solar System materials and measurable variations in the ¹⁴²Nd/¹⁴⁴Nd 99 ratios, the origin of the terrestrial ¹⁴²Nd signature compared to the chondrite 100

101 meteorites is still unclear. The isotope signature of some ocean island basalts is 102 difficult to interpret without an early event that would fractionate the Sm/Nd ratio of 103 the bulk silicate Earth very early on in its history (Jackson et al., 2010). Here we re-104 evaluate the small isotopic variations measured in enstatite chondrites. Such 105 meteorites were formed under reducing conditions and have a particular mineral 106 assemblage. Importantly for interpreting their Sm-Nd systematics, half of the rare 107 earth element (REE) budget is hosted in oldhamite (CaS), which is easily altered to 108 Ca-sulphate by weathering (Crozaz and Lundberg, 1995; Gannoun et al., 2011).

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110 We have compiled all the Nd isotope data published on EC so far. We also 111 present the first measurements on an observed fall Almahata Sitta containing 112 fragments of the EL3 subgroup, such as the fragment MS-177. The fireball of Almahata Sitta fall was captured on camera in northern Sudan on October 7th 2008. 113 114 Its trajectory was back-tracked to a small asteroid called 2008 TC₃ (Bischoff et al., 115 2010). Additionally, REE concentration measurements are presented for samples 116 belonging to the two subgroups of enstatite chondrites (EH and EL). Since the identification of ¹⁴²Nd variations attributed to nucleosynthetic anomalies requires a 117 118 comparison at the same Sm/Nd evolution, we present in detail two methods of 119 calculations used for normalization of all chondrites to a common Sm/Nd and the difficulties inherent to the enstatite chondrite sub-groups. The ¹⁴²Nd/¹⁴⁴Nd ratios are 120 121 then compared to the corresponding mass independent stable Nd isotope ratios for 122 each meteorite to establish their significance with respect to the distribution of 123 nucleosynthetic anomalies amongst the chondrite groups. Finally, their potential 124 contributions as Earth's building blocks are discussed.

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127 2. Samples and Methods

- 128 **2.1. Trace element contents in EC**
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130 Rare earth element concentrations have been measured for 12 EC from EH (4) 131 and EL (8) sub-groups. The meteorite names and sample subgroups are reported in 132 Table 1. Two techniques of dissolution have been used: 1) samples were digested in 133 PFA Savillex® beakers using a mixture of concentrated HF-HNO₃ acids in 3:1 134 proportion at 120°C on hot plate during 48h; 2) samples were digested in individual 135 Parr® pressure vessels in concentrated HF-HNO₃ (10:1) for 5 days at 155°C. In both 136 cases, after drying down the samples, perchloric acid was added and evaporated on a 137 hot plate to break down the fluorides. After successive dissolution/evaporation cycles 138 in concentrated HNO₃, samples were taken back into solution in PFA Savillex® 139 beakers or in Parr® pressure vessels in 6M HCl. All measurements were performed 140 using the Agilent 7500 quadrupole ICP-MS at the Laboratoire Magmas et Volcans 141 (LMV) in Clermont-Ferrand, with the exception of Almahata Sitta MS-177 and 142 Hvittis that were measured at the University Western Ontario using a Thermo iCAP 143 Qc quadrupole ICP-MS. Both ICP-MS are equipped with He collision cells. Samples 144 were measured in HNO₃ 0.5M- HF 0.05 M and HNO₃ 0.3M- HF 0.01 M in the two 145 laboratories, respectively. Counts per second were calibrated using rock standards 146 BCR-2, BHVO-2 or BIR 1a. The rock standards and a synthetic standard solution 147 (CMS) were routinely analyzed to validate the efficiency of the digestion procedures 148 and the accuracy and precision of the acquired data. Blank and standard solutions 149 were measured every 4 samples. Both the external reproducibility estimated from repeated measurements of the standards and the accuracy checked from certified rockstandard analyses are lower than 5%.

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154 2.2. ^{146,147}Sm-^{142,143}Nd systematics and mass independent stable Nd isotopes

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156 Here we report new results for MS-177 (Table 2). After the Parr bomb 157 digestion of the samples at the University of Western Ontario, following the methods 158 detailed in Bouvier and Boyet (2016), an aliquot of about ~80% was used for isotopic composition, ~10% fraction was spiked with an enriched ¹⁴⁹Sm-¹⁵⁰Nd mixed spike to 159 160 determine precisely the Sm/Nd ratios by isotopic dilution, and another 10% aliquot 161 was used to determine Q-ICPMS REE concentrations. The Sm and Nd of the spiked 162 fractions were purified and separated using a two-stage chemistry procedure (cationic 163 AG50W-X8 and Ln-spec resins). This procedure was also used for a BCR-2 USGS 164 basalt standard (aliquot of 1.1 mg) to ensure accuracy and reproducibility of our 165 spiked and unspiked measurements. Both spiked Sm and Nd isotopic fractions were 166 analyzed using a MC-ICPMS Neptune Plus at LMV.

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The separation procedure for the Nd isotopic composition required 3 steps as described in Garçon et al. (2018). The Ce was separated from other trivalent REE using the oxidation of Ce to Ce⁴⁺ on Ln-Spec resin (Tazoe et al., 2007; Li et al., 2015). Then the separation between Nd and Sm was achieved on Ln-Spec resin using 0.20N to 0.25N HCl. Total procedural blanks are genrally lower than a few tens of pg for Nd. The Nd isotopic compositions were measured as Nd⁺ using the LMV Triton PlusTM Multicollector Thermal Ionization Mass Spectrometer. For MS-177, Nd 175 isotope ratios were obtained in static mode following the method described in 176 Gannoun et al. (2011a). Static measurements were preferred because the amount of 177 Nd was small (~300 ng for MS-177) and dynamic routines require large sample size 178 (e.g. 750 ng for the 4-line acquisition scheme developed by Garcon et al., 2018). In 179 addition, we used a mass spectrometer equipped with new faraday collectors (6 180 month-old). No sign of deterioration of the faraday collectors was identified during 181 the measurements. Ce and Sm contributions, monitored at masses 140 and 147 182 respectively, were lower than 3 ppm on masses 142 and 144 for both standard and 183 sample measurements. Nd isotope ratios were corrected for mass fractionation to ¹⁴⁶Nd/¹⁴⁴Nd=0.7219 using the exponential mass-fractionation law. The external 184 185 reproducibility (2SD) calculated from 6 repeated measurements of the JNdi-1 standard is 5.6 ppm on ¹⁴²Nd/¹⁴⁴Nd, 7.4 ppm on ¹⁴³Nd/¹⁴⁴Nd, 4.4 ppm on ¹⁴⁵Nd/¹⁴⁴Nd, 186 8.2 ppm on 148 Nd/ 144 Nd, and 10.9 ppm on 150 Nd/ 144 Nd (Table 2). 187

188

189 **3. Results**

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191 The new REE data are reported in Table 1 and compared to published values 192 from Gannoun et al. (2011b) and Barrat et al. (2014) in Figure 1. Data from 193 Kalleymen and Wasson (1986) is not shown in Figure 1 because they reported the 194 concentrations of only 5 REEs (La, Sm, Eu, Yb, and Lu), which is insufficient to 195 define proper REE patterns. All EH samples have flat REE patterns with 196 concentrations very similar to those reported in CI, except Kota Kota (EH3) that is 197 enriched in LREE (Figure 1A). This split is the most visibly weathered in color and 198 texture of our collection, and the meteorite was described as a strongly weathered EC by Leitch and Smith (1982). The measured sub-chondritic ¹⁴³Nd/¹⁴⁴Nd ratio of Kota 199

200 Kota suggests that this sample has a complex history with several episodes of 201 fractionation of the Sm/Nd ratio (Gannoun et al., 2011b). Two EH samples display 202 unusual REE patterns: Galim (b) and LAP 0225 (Figure 1A, data from Barrat et al. 203 2014). They are classified as impact melt (IM) and their REE patterns are in 204 agreement with the petrological description of the samples (Michel-Lévy and Bourot-205 Denise, 1988; Russel et al., 2004). EL samples present more variable REE 206 distributions. Most of EL3 samples display flat REE patterns with concentrations 207 ranging between 0.6 to 2 times the CI values. MAC 88180 is more enriched in REE (x2 CI) and has a negative Eu anomaly (Eu/Eu*= $Eu_{CI}/(Sm_{CI}^{1/2}x Gd_{CI}^{1/2})$ of 0.7 (Figure 208 209 1C). Similar REE patterns have been obtained following the two dissolution 210 techniques. Almahata Sitta MS-177, which is the most depleted EL3 sample, has a 211 positive Eu anomaly of 1.5. The REE pattern for MS-177 is more similar to Adrar 212 Bous (EL5) with lower REE contents and large positive Eu anomalies (Eu/Eu*=1.3). 213 EET 92063 has a REE pattern with similar characteristics but REE contents are even 214 lower and the Eu positive anomaly is higher (Figure 1D). This sample is described as 215 highly weathered and classified in an anomalous EL6 group by Barrat et al. (2014). 216 By contrast, all other EL6 samples display negative Eu anomalies and are called 217 "normal EL6" by the same authors. EL6 samples are all depleted in LREE relative to 218 HREE ($(La/Lu)_N$) up to 0.62. Chemical heterogeneities are observed within the same 219 sample. For example Hvittis has been measured 4 times and Eu/Eu* varies from 0.8 220 to 1.0 depending on the split analyzed. Petrological observations show that all these 221 samples are strongly heterogeneous at millimeter to centimeter scale. Rare earth 222 element distribution in the different EC subgroups is presented in Figure 2. This time, 223 the database for REE in enstatite chondrites from Kallemeyn and Wasson (1986) is 224 included. All subgroups have similar Yb concentrations but different (La/Sm)_N ratios.

Strong depletions in incompatible elements, hence low La/Sm ratios, are measured in EL6 samples and the two samples characterized by an unusual mineralogical assemblage (Galim (b) and LAP 0225). Then EL6 samples are clearly different from other EL samples. We note that the La/Sm ratios in EH are more variable and in average higher than those measured in EL3-5 samples.

230 Measured Nd isotope ratios for MS-177 are expressed in ppm deviation 231 relative to the reference JNdi-1 standard (µ-value) in Table 2 and all details on 232 measurements (isotope ratios, intensity, interferences, etc) are available in 233 Supplementary information (Table S2). This sample presents a small deficit of -11 ppm in ¹⁴²Nd/¹⁴⁴Nd whereas all stable isotope ratios are identical within errors to the 234 JNdi-1 standard values. The ¹⁴⁷Sm/¹⁴⁴Nd ratios calculated using the isotope dilution 235 method are 147 Sm/ 144 Nd = 0.1381 for the BCR-2 standard and 0.1897 for MS-177. 236 237 Our repeated spiked Sm-Nd measurements of BCR-2 standard at LMV give an average of 147 Sm/ 144 Nd = 0.1381 ± 0.0003 (2SD, n=4), thus a precision of 0.2%. This 238 value is within literature values which range from ${}^{147}\text{Sm}/{}^{144}\text{Nd} = 0.1357$ to 0.1396 and 239 identical within errors with the most recent determination by ID TIMS at 0.1379 240 ± 0.0002 (2SD; Li et al., 2012 and references therein). The initial ¹⁴³Nd/¹⁴⁴Nd ratio for 241 MS-177 calculated at 4.568 Ga is ε^{143} Nd = +0.06 ±0.25 when normalized to the initial 242 for the Solar System composition using the chondrite average (CHUR) ¹⁴⁷Sm/¹⁴⁴Nd 243 and ¹⁴³Nd/¹⁴⁴Nd ratio values (Bouvier et al., 2008). 244

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247 4. Discussion

248 4.1. ^{146,147}Sm-^{142,143}Nd systematics in enstatite chondrites

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250 The purpose of this paper is to take a more rigorous look at enstatite 251 chondrites and their genetic relationship to the Earth. To compare the compositions of 252 enstatite chondrites to other chondrite groups, we compiled all Nd data published on 253 chondrites from this group so far, as well as new data. This compilation is provided in 254 supplementary materials. Available data comes from 7 different publications: Boyet 255 and Carlson (2005); Rankenburg et al. (2006); Carlson et al. (2007); Gannoun et al. 256 (2011); Bouvier and Boyet (2016); Burkhardt et al. (2016); and Fukai and Yokohama 257 (2017). For the studies using La Jolla Nd standard for the calculation of deviation in 258 ppm relative to the terrestrial value (μ Nd), the data were recalculated relative to the 259 JNdi-1 terrestrial standard. The two synthetic standards La Jolla and AMES record 260 significant mass-dependent variability and then cannot be used as a reference either 261 for the BSE or the modern mantle (O'Neil et al., 2008; Gautam et al., 2017; Saji et al., 262 2016). All the measurements have been obtained on large-size samples (1-2 g). The 263 Nd isotope compositions obtained for the Allende CV3 chondrite using different 264 methods of digestion (table-top acid-digested, Parr bomb acid-digested and alkali-265 fused acid-digested samples) are similar (Boyet and Carlson, 2005; Carlson et al., 266 2007). The complete digestion of refractory components may be an issue for some 267 elements but not for Nd. Presolar SiC grains are a primary carrier of large Ba isotope 268 anomalies and the destruction of these grains during the digestion is required 269 (Bermingham et al., 2016). When measuring the Nd isotope composition of extra-270 terrestrial materials, an additional consideration is to take into account the potential 271 neutron capture effects due to the interaction of materials with galactic cosmic rays. 272 However previous studies have measured very small deviations in the ¹⁴⁹Sm abundance of chondrites which is one of the Sm isotopes having the largest thermal 273 274 neutron capture cross section. This suggests that chondrites have not been

significantly affected by neutron fluence effects and that the correction on ¹⁴²Nd/¹⁴⁴Nd 275 276 ratios is negligible or within the measurement precision (e.g. Boyet and Carlson, 277 2005; Bouvier and Boyet, 2016). McCoy-West et al. (2017) have determined the 278 mass-dependent stable Nd isotope composition using a double spike technique. 279 Chondrites and terrestrial samples have identical isotopic compositions with δ^{146} Nd/¹⁴⁴Nd= -0.025 ± 0.025‰ (2SD; n=39) and δ^{146} Nd/¹⁴⁴Nd= -0.022 ± 0.034‰ 280 281 (2SD; n=30) respectively. These results imply that no bias is produced by the 282 correction of instrumental mass fractionation effects when processing the raw data.

283

The first high-precision ¹⁴²Nd measurements on chondrites have shown that 284 differences in ¹⁴²Nd/¹⁴⁴Nd ratios existed among chondrite groups and that these 285 286 variations were not correlated with changes of Sm/Nd ratios (Boyet and Carlson 287 2005). The new compilation combining all data measured on chondrites since 2005 288 leads to the same conclusion. The different groups of chondrites have different measured ¹⁴²Nd/¹⁴⁴Nd values (Figure 3A). We note that results obtained from 289 290 different chondrite fragments which were processed in different labs using different 291 analytical techniques are in good agreement. On average carbonaceous chondrites (CC) have a μ^{142} Nd of -31 ± 20 (2SD) ppm, ordinary chondrites (OC) of -16 ± 9 292 293 (2SD) ppm and EC of -12 ± 21 (2SD) ppm. Although standard deviations overlap, 294 two sample t-tests strongly suggest that the three populations of chondrites are distinct from each other with p-values lower than 0.05 (p-value CC-OC = 1.5×10^{-8} ; p-value 295 $CC-EC = 8.9 \times 10^{-10}$; p-value OC-EC = 0.004). Five samples have $^{147}Sm/^{144}Nd$ ratios 296 297 far from the CHUR value of 0.1960 (dashed line in Figure 4A and 4B; Bouvier et al., 298 2008): NWA 2090 (CO3) and Tagish Lake (C2-ungrouped, not represented in the figure: ¹⁴⁷Sm/¹⁴⁴Nd=0.148) for CC, Adrian (H4) for OC (not represented in the figure: 299

¹⁴⁷Sm/¹⁴⁴Nd=0.137), and Kota Kota and Blithfield for EC. Moreover one EC sample 300 displays an extreme μ^{142} Nd value and this measurement has a large error bar (Abee: -301 44 ± 17 (2SE) ppm (Boyet and Carlson 2005). When all these samples are excluded 302 from the averaging calculation, CC have a μ^{142} Nd of -33 ± 16 (2SD) ppm, OC of -16 303 304 \pm 9 (2SD) ppm and EC of -11 \pm 12 (2SD) ppm. All these groups have similar measured Sm/Nd ratios even if a larger range is observed for EC (Figure 4A, B). 305 When the same samples are selected, the mean ¹⁴⁷Sm/¹⁴⁴Nd ratios of each group is 306 307 0.1959 ± 0.0046 (2SD) for CC, 0.1946 ± 0.0033 (2SD) for OC and 0.1950 ± 0.0084 308 (2SD) for EC. The median values are equal to 0.1953, 0.1951 and 0.1952 for these 3 309 groups, respectively. CC and OC have normal distributions whereas EC present a 310 larger scatter. These values are slightly lower than the CHUR value of $0.1960 \pm$ 311 0.0004 (2SD) defined from the average of unequilibrated chondrites (Bouvier et al., 312 2008) but are similar within uncertainties. Two sample t-tests further confirm that the mean ¹⁴⁷Sm/¹⁴⁴Nd ratios of the three populations are undistinguishable from each 313 other since p-values are much higher than 0.05 (p-value CC-OC = 0.9; p-value CC-314 EC = 0.3; p-value OC-EC = 0.3). 315

316

The measured abundance of ¹⁴²Nd comes from two distinct contributions: its initial abundance and the quantity produced with time by the decay of ¹⁴⁶Sm. Since ¹⁴⁶Sm was alive only during the first 500 Ma of Solar System history, we can write the following equations:

321
142
Nd_{meas} = 142 Nd_{T0} + 146 Sm_{T0} (1)

322
$$({}^{142}Nd/{}^{144}Nd)_{meas} = ({}^{142}Nd/{}^{144}Nd)_{T0} + ({}^{146}Sm/{}^{144}Nd)_{T0}$$
 (2)

323 where $_{meas}$ denotes the abundance or isotopic composition measured today in 324 chondrites and $_{T0}$ the initial abundance or isotopic composition at the time of 325 formation.

These equations show that any fractionation of the Sm/Nd ratio during the ¹⁴⁶Sm 326 lifetime will significantly affect the measured ¹⁴²Nd/¹⁴⁴Nd ratios. In order to compare 327 initial ¹⁴²Nd/¹⁴⁴Nd ratios between chondrites, the data are thus corrected from the 328 ¹⁴²Nd radiogenic production since the formation of the Solar System and normalized 329 to a common chondritic evolution following the CHUR parameters defined by 330 331 Bouvier et al. (2008). Two different methods of calculation can be used assuming a 332 modification of the Sm/Nd ratio either early in the Solar system history or once the ¹⁴⁶Sm-¹⁴²Nd systematics is extinct. 333

334

335 Method A. ¹⁴²Nd/¹⁴⁴Nd corrected using measured ¹⁴⁷Sm/¹⁴⁴Nd ratios

This correction is illustrated in Figure 5A. The ¹⁴²Nd/¹⁴⁴Nd ratio of the sample is calculated back in time to the age of the Solar System formation, *i.e.* 4.568 Ga (Bouvier and Wadhwa, 2010) using the *measured* ¹⁴⁷Sm/¹⁴⁴Nd ratio. From this initial ¹⁴²Nd/¹⁴⁴Nd ratio, a modern value is recalculated using the CHUR ¹⁴⁷Sm/¹⁴⁴Nd ratio of 0.1960 (Bouvier et al., 2008). Such a correction assumes that the modification of the Sm/Nd ratio occurred at the beginning of Solar System history i.e. when the chondrites form.

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344 Method B. ¹⁴²Nd/¹⁴⁴Nd corrected using measured ¹⁴³Nd/¹⁴⁴Nd ratios

This correction, illustrated in Figure 5B, does not consider the *measured* ¹⁴⁷Sm/¹⁴⁴Nd ratio but instead the *integrated* ¹⁴⁷Sm/¹⁴⁴Nd ratio calculated from the ¹⁴⁷Sm-¹⁴³Nd long-lived radiogenic systematics. Since recent changes of Sm/Nd ratios, for example due to weathering, are not recorded in the evolution of ¹⁴³Nd/¹⁴⁴Nd ratios, the ¹⁴⁷Sm/¹⁴⁴Nd ratio is deduced from the measured ¹⁴³Nd/¹⁴⁴Nd ratios considering that all samples evolved from the same initial ¹⁴³Nd/¹⁴⁴Nd value of 0.506686 which corresponds to the composition of the CHUR at 4.568 Ga (Bouvier et al., 2008). Then, the normalized-CHUR ¹⁴²Nd/¹⁴⁴Nd ratio is calculated following the steps described in Method A using the ¹⁴⁷Sm/¹⁴⁴Nd ratio of the CHUR from 4.568 Ga to present-day.

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To evaluate the influence of the chosen method on the CHUR-normalized 356 μ^{142} Nd values, we re-corrected all published ¹⁴²Nd/¹⁴⁴Nd ratios with the two methods 357 358 and compared the results in Figure 3B and C. Note that the Sm/Nd ratios of OC and 359 CC from Fukai and Yokoyama (2017) were measured by quadrupole ICPMS and are 360 thus reported with a much lower precision (1-1.5%) than that typically obtained 361 (about 0.2%) by isotope dilution with MC-ICPMS measurements of the spiked Sm and Nd isotopic compositions. Such a large uncertainty on Sm/Nd ratios propagates to 362 errors of about 10 ppm on the CHUR-normalized $\mu^{142}Nd$ values. Fukai and 363 Yokovama (2017) did not need to determine the precise ¹⁴⁷Sm/¹⁴⁴Nd ratios of their 364 samples because they used the method B to calculate their normalized μ^{142} Nd values. 365 However, we encourage future studies to systematically measure both the Nd isotope 366 367 composition and the corresponding Sm/Nd ratio at high precision using the isotope 368 dilution method.

369

Weighted averages for CC, OC and EC are -32 ± 13 (2SD), -15 ± 9 (2SD), -8 ± 15 (2SD) for the method A and -32 ± 13 (2SD), -16 ± 9 (2SD), and -10 ± 12 (2SD) for the method B. Mean values are identical within errors but when looking at the data

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373 in further details, significant differences are identified within the EC group. This is 374 illustrated in Figure 4C where both methods of correction are compared. For CC and OC, all ¹⁴²Nd/¹⁴⁴Nd ratios plot along the 1:1 line whereas the EC show a larger 375 376 scatter. This scatter indicates that changes in the Sm/Nd ratios of EC have occurred at different times, probably early in the Solar System history and recently by 377 378 weathering. The larger dispersion of the Sm/Nd ratios observed in EC may be 379 explained by their unique mineralogy as they formed under extreme reducing 380 conditions. Larimer and Bartholomay (1979) suggested that EC formed within a 381 region in the solar nebula with a high C/O ratio (>1). Although rare earth elements are 382 mainly carried by silicate minerals in other chondrite groups, about half of the Sm and 383 Nd elemental budget of EC is hosted in oldhamite, which is a Ca-sulfide (CaS). In-384 situ measurements indicate that CaS are very rich in REE relative to CI chondrites (10 385 to 100 times the CI values; Crozaz and Lundberg, 1995; Gannoun et al., 2011b). In 386 EH3, the CaS have fractionated REE patterns with an enrichment in LREE relative to 387 HREE ((La/Yb)_N= 1-15) and positive anomalies in Eu and Yb (Crozaz and Lundberg, 388 1995; Gannoun et al., 2011b). Although in-situ REE measurements of CaS were 389 conducted only in EH3 samples, the measurements carried out in other groups of EC 390 and in aubrites (reduced enstatite achondrites) show diverse REE patterns which may 391 be associated with the weathering of CaS (Floss et al., 1990; Floss and Crozaz, 1993; 392 Crozaz and Lundberg, 1995). Petrological observations have shown that CaS are not 393 uniformly distributed in enstatite chondrites from EH and EL subgroups. In EH, CaS 394 is mainly included in metal-sulfide nodules even if it can be present in the matrix or in 395 chondrules dominated by silicate phases (El Goresy et al., 1988; Gannoun et al., 396 2011b; Piani et al., 2016). Our observations of EL3 samples suggest that CaS is 397 mostly found in chondrules where it is intimately intergrown with enstatite and 398 occasionally with diopside (El Goresy et al., 2017). Its occurrence in metal-dominated 399 nodules is less common. Although metal-sulfide nodules are more subject to oxidation/weathering than silicate assemblages, CaS enclosed in metal should be 400 401 better preserved because metal has no fracture veins like silicates. No clear 402 relationship has been found between REE fractionation and the type of samples 403 (group, fall vs. found, etc). To minimize the amplitude of the correction on ¹⁴²Nd/¹⁴⁴Nd ratios and reduce the errors caused by a potential Sm/Nd fractionation 404 during weathering, we selected a subset of EC samples (11 samples, 16 405 measurements) with measured ¹⁴⁷Sm/¹⁴⁴Nd ratios very close to the CHUR value i.e. 406 407 between 0.1926 and 0.1994 ($\pm 1.7\%$). Within this range, the correction reaches a maximum of \pm 5 ppm on the ¹⁴²Nd/¹⁴⁴Nd ratios, i.e. equivalent to the average external 408 reproducibility. Taking only this subset of EC samples yields an average μ^{142} Nd of -409 410 10 ± 12 (2SD) for the two methods A and B, hence does not change the mean nor 411 improve the standard deviation obtained for the whole EC group.

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414 **4.2.** Stable Nd isotope signature of EC relative to other groups

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Neodymium has 7 isotopes from mass 142 to 150. Nucleosynthetic anomalies, which are mass-independent variations, can be identified by measuring 3 stable isotope ratios: $^{145}Nd/^{144}Nd$, $^{148}Nd/^{144}Nd$ and $^{150}Nd/^{144}Nd$. Both $^{142}Nd/^{144}Nd$ and $^{143}Nd/^{144}Nd$ are modified by radiogenic productions from ^{146}Sm and ^{147}Sm respectively, and $^{146}Nd/^{144}Nd$ is used for internal mass bias correction and normalization to a common ratio value of 0.7219. Except ^{142}Nd which is mainly produced by *s-process* and ^{150}Nd which is a pure *r-process* nuclide, all other isotopes 423 are formed by a combination of s- and r-processes in different stellar environments 424 (Arlandini et al., 1999; Bisterzo et al., 2011). A change in the -s/-r proportions thus modifies the Nd isotope patterns. Excess in s-process produces excess in ¹⁴²Nd and 425 deficits in ¹⁴³Nd, ¹⁴⁵Nd, ¹⁴⁸Nd and ¹⁵⁰Nd with the deficits increasing from mass 143 to 426 427 mass 150. Measurements obtained on individual EC are presented in Figure 6. The 428 average values for both CC and OC groups are shown for comparison. For clarity, 429 errors bars (2SD) are not shown in the figure but are instead provided in the figure 430 caption. The large errors calculated for CC reflect the variability of s-process nuclides among this group owing to the contribution of CAIs. In a μ^{150} Nd vs μ^{148} Nd binary 431 432 plot, bulk CC and separated CAIs plot on the mixing line calculated from isotope 433 production in stellar models (see Fig. 3 in Bouvier and Boyet, 2016). CAIs can be the carrier of large s-process excess signature with deficits in $\mu^{148}Nd$ and $\mu^{150}Nd$ of 434 435 several tens of ppm (Brennecka et al., 2013; Marks et al., 2014; Bouvier and Boyet, 436 2016).

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438 The compositions of EC are scattered in the 3 binary plots without any clear 439 correlation (Figure 6). Results of mixing of the s-model prediction with the terrestrial 440 composition are indicated by the dashed lines depending on the model used: 1) stellar 441 model by Arlandini et al. (1999) or 2) using the composition of SiC as representative of a pure s-process component (Hopp and Ott, 1997). Deficits in ¹⁴²Nd measured in 442 443 enstatite chondrites from the EH group and the EL6 subgroup are small and equal to -444 11 ppm in average. For such small deficit, the expected deviations in 145, 148 and 445 150-Nd are equal to +5, +11 and +17 ppm, respectively. These variations remain very 446 small in comparison to the measurement precision (external reproducibility) obtained 447 with the last generation of multi-collector thermal ionization mass spectrometers

(TIMS). In the recent study of Burkhardt et al. (2016), both ¹⁴²Nd/¹⁴⁴Nd and 448 ¹⁴⁸Nd/¹⁴⁴Nd ratios were measured using a dynamic procedure leading to better 449 450 external reproducibilities than static measurements. The relative deterioration of the 451 Faraday collectors and their change of efficiency through time are important sources 452 of imprecision and inaccuracy for the determination of isotope ratios using static 453 multicollection (Makishima and Nakamura, 1991; Thirlwall, 1991). However, even with dynamic procedures on TIMS, the external reproducibilities for ¹⁴⁸Nd/¹⁴⁴Nd 454 455 reach 11 and 15 ppm on repeated measurements of the BHVO-2 rock standard and 456 JNdi-1 standard, respectively. Better precisions have been recently reported by Saji et 457 al. (2016) using multi-collector inductively coupled plasma mass spectrometry and a 458 sample-standard bracketing technique. Five measurements of the carbonaceous chondrite Allende (CV3) give an external reproducibility of 1 ppm on the ¹⁴⁸Nd/¹⁴⁴Nd 459 460 ratio with intensity of 14 V at mass 142. Because enstatite chondrites are about 2 461 times more depleted in Nd than CV3 carbonaceous chondrites, this technique would 462 require large quantities of EC samples (i.e. 2 g). A new 4-mass-step acquisition 463 scheme developed by Garçon et al. (2018) by thermal ionization mass spectrometry is 464 very promising because this routine is able to return all Nd isotope ratios dynamically 465 and provide a robust evaluation of the data to assess the quality of the data (e.g., 466 mixing effects on the filament, fractionation between acquisition steps).

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469 **4.3.** The isotope similarity between EL3 samples and the Earth

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471 Amongst all the classified meteorites, enstatite chondrites represent only 2%472 of the chondrites with 189 and 160 samples for the EH and the EL subgroups,

473 respectively. They have been distinguished on the basis of their Fe/Si bulk ratios as 474 high-Fe (EH) or low-Fe (EL) (Sears et al., 1982; Kallemeyn and Wasson, 1986). The 475 two EC subgroups also differ in their sulfide mineralogy. In addition to troilite (FeS), 476 daubréelite (FeCr₂S₄) and oldhamite, which are common to both EH and EL 477 subgroups, niningerite (MgS) is the diagnostic sulfide of EH, whereas alabandite 478 (MnS) is specific to EL. Most of enstatite chondrites are found objects that may have 479 been affected by weathering during their long residence time at the Earth surface. Fall 480 objects are extremely rare with only 7 samples for EH (2 EH3: Parsa and Oingzhen; 3 481 EH4: Abee, Adhi Kot, Indarch; 2 EH5: St. Mark's and Saint-Sauveur; Itqiy and 482 Galim (b) are classified as EH but present highly fractionated trace element patterns), 483 whereas 8 fall samples for EL are all from the EL6 group, except small fragments 484 from the newly discovered Almahata Sitta meteorite. This meteorite was classified as 485 a polymict ureilite and contains EC fragments of a few grams amongst a variety of 486 lithologies. Fragment MS-177 was originally assigned an equilibration grade as EL3/4 487 with claimed impact-melt metal pockets (Bischoff et al., 2010). In contrast, El Goresy 488 et al. (2017) argued for an origin by condensation based on the study of textures and 489 sulfide mineral chemistries. REE patterns reported for EL6 samples are fractionated 490 (Figure 1). Rubin et al. (2009) claims this depletion observed in many EL6 and some 491 more primitive EL as a result of impact processes. EL6 samples would then represent 492 a residuum largely depleted in LREE and Ca. No evidence for claimed impact melting 493 was reported by El Goresy et al. (2017) in any EH or EL investigated. The good agreement observed between μ^{142} Nd values corrected using Methods A and B for EL6 494 495 samples supports a fractionation event early in the history of the parent body. Ar-Ar isochron ages suggest closure of the K-Ar system at 4.45-4.49 Ga for EL5 and EL6 496 497 chondrites (Hopp et al., 2014).

499	When the 142 Nd/ 144 Nd ratios are classified by metamorphic types (Figure 7),
500	there is no difference for samples from the EH group. In contrast, two different
501	populations are distinguished for the EL samples. EL6 samples have a larger deficit in
502	¹⁴² Nd with an average of -12.7 \pm 6.0 (2SD) ppm when corrected with method B. EL3
503	samples have a $\mu^{142}Nd$ value similar to the terrestrial standard within the error bars: -
504	0.8 ± 7.0 (2SD) ppm. The p-value from two sample t-test yields 0.001, meaning that
505	the EL3 and EL6 populations likely do not share the same ¹⁴² Nd means when
506	corrected with method B. Samples form EL3 and EL6 subgroups are also statistically
507	different when considering the two-sided Student's <i>t</i> -values 95% confidence intervals
508	: μ^{142} Nd EL3= -0.8 ± 4.4 ppm and μ^{142} Nd EL6= -12.7 ± 2.3 ppm (see Table S1). This
509	difference suggests either that EL3 and EL6 samples come from different parent
510	bodies or that the correction for the ¹⁴² Nd radiogenic production is not correct for EL6
511	samples. The correction assumes an evolution over 4.568 Ga while Ar-Ar isochron on
512	EL6 samples (Hopp et al., 2014) suggests a fractionation event 70 Ma after the
513	beginning of the solar system history. Considering a two-stage evolution (chondritic
514	147 Sm/ 144 Nd ratio of 0.196 from T ₀ to T ₁ with T ₀ -T ₁ = 70 Ma, the EL6 average
515	$^{147}\text{Sm}/^{144}\text{Nd}$ ratio of 0.2005 from T_1 to present time shifts the correction by -2 ppm
516	only. This average value $\mu^{142}\text{Nd}$ for EL6 remains statistically different from the EL3
517	subgroup. Another compelling result for the difference amongst EC compositions
518	comes from the measurement of Ru isotopes (Fischer-Gödde and Kleine, 2017).
519	Although the average of all EH and EL chondrites has a small deficit in $\epsilon^{100} Ru$ (-0.08
520	\pm 0.04, 95% confidence interval of the mean), the sample suite includes only one EL3
521	PCA 91020. This EL3 gave $\epsilon^{100}Ru = +0.02$ which is outside the 95% confidence
522	interval of the average of the combined EL and EH data and similar to the Earth's

523 composition. A difference between Earth and EC has been reported for Mo isotopes 524 but no EL3 samples have been analyzed in this dataset meaning that the reported 525 average Mo isotopic composition of EC is based on EL6 samples only (Burkhardt et 526 al., 2011; Dauphas et el., 2002; Dauphas 2017). The Zn isotopic compositions of the 527 two EL3 chondrites measured by Moynier et al. (2011) are also identical to the 528 terrestrial values, whereas the analyzed EL6 chondrites are all enriched in heavy 529 isotopes and highly depleted in Zn. The origin of the volatile element depletion 530 between EL3 and EL6 chondrites can be explained by volatilization, probably during 531 thermal metamorphism. All these measurements suggest that EL samples do not come 532 from a single parent body. Similar conclusions were reached from petrographic and 533 geochemical observations for EH3 samples. Both normal and reverse MgS-FeS 534 zoning profiles in niningerite grains adjacent to troilite reveal an origin on different 535 parental asteroids with different MnS-contents in the niningerites (Lin and El Goresy, 536 2002; Gannoun et al., 2011b). At least 8 different parent bodies have been recently 537 proposed for the entire EC group based on chemical variations measured in sulfide 538 and metal phases (Weyrauch et al., 2017). However all these samples share very close 539 isotope signatures suggesting they condensed within the same region of the solar 540 nebula. Although our conclusion supports a genetic relationship between EL3 samples 541 and the Earth, this statement is based on the analysis of cosmochemical materials 542 present in our meteorite collection that represent a vey small record of materials 543 present in the Solar System. Recent high-precision Mo and Ru isotope measurements 544 have highlighted a terrestrial signature in IAB iron meteorites indicating that their 545 parent bodies could be the building blocks of the Earth (Worsham et al., 2017). 546 Unfortunately the lithophile behavior of REE makes it impossible to study these meteorites for ¹⁴⁶Sm-¹⁴²Nd systematics. 547

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- 550 **5.** Conclusion
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Among all groups of chondrites, EC have measured ¹⁴²Nd/¹⁴⁴Nd ratios the 552 closest to the modern terrestrial signature (μ^{142} Nd= -11 ±12 (2SD) ppm). In order to 553 compare initial ¹⁴²Nd/¹⁴⁴Nd ratios, data must be corrected from the ¹⁴²Nd radiogenic 554 555 production since the formation of the Solar System. Two methods of corrections are compared (*measured* ¹⁴⁷Sm/¹⁴⁴Nd vs. *integrated* ¹⁴⁷Sm/¹⁴⁴Nd ratios). The two methods 556 yield results that are identical within the errors bars. Enstatite chondrites show a 557 558 larger scatter of Sm/Nd ratios in comparison to other chondrite groups that can be 559 attributed to early fractionation processes (e.g. samples from the EL6 subgroup) 560 and/or recent changes caused by weathering. In these chondrites, REE are mainly 561 concentrated in the calcium-sulfide phase (oldhamite), which is very sensitive to 562 weathering. For this latter reason we conclude that corrections based on *integrated* ¹⁴⁷Sm/¹⁴⁴Nd ratios are more accurate for enstatite chondrites. The average of these 563 corrected values μ^{142} Nd give -10 ±12 (2SD) ppm. We report no significant variation 564 in the 3 stable Nd isotope ratios (¹⁴⁵Nd/¹⁴⁴Nd, ¹⁴⁸Nd/¹⁴⁴Nd and ¹⁵⁰Nd/¹⁴⁴Nd) in EC 565 566 relative to terrestrial Nd standard.

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When the ¹⁴²Nd/¹⁴⁴Nd ratios are ordered by enstatite chondrite sub-groups, there is no difference for samples from the EH sub-group. In contrast, two different populations are distinguished for the EL sub-group. EL6 samples have a larger deficit in ¹⁴²Nd with an average of -12.7 \pm 6.0 (2SD) ppm. EL3 samples have a μ^{142} Nd value similar to the terrestrial standard within the error bars: -0.8 \pm 7.0 (2SD) ppm. These

two populations are statistically different (p-values and 95% confidence interval 573 574 uncertainties). These results are in agreement with those obtained for other elements 575 (e.g. Zn and Ru) and suggest that 1) EL3 and EL6 samples do not come from the 576 same parent body, and 2) EL3 samples are isotopically similar to the Earth. Because 577 these enstatite chondrites are relatively small in size and number, they are usually not 578 available for destructive isotopic measurements. Average values based on both the 579 geochemical and isotopic compositions of EL6 samples should not be considered as 580 representative of the whole EL group. The enstatite chondrite model (Javoy, 1995; 581 Javoy et al., 2010, Kaminski and Javoy, 2013) considers instead that the Earth is built 582 from essentially pure EH material for explaining the Mg/Si ratio of the Earth's upper 583 mantle. A better knowledge on the mineralogy of the lower mantle and the proportion 584 of silicon in the Earth's core could help in resolving this discrepancy.

585

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587

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796 Figure 1. Rare earth element (REE) patterns measured in enstatite chondrites from 797 both EH and EL subgroups normalized to CI chondrites (Anders and Grevesse, 1989). 798 New data are represented in black and Grey fields/line are data from Barrat et al. 799 (2014) A) EH3 and impact melts (IM). LAP 02225 is an impact melt (Antarctic 800 meteorite newsletter, Izawa et al., 2010). Galim is an unusual LL/EH polymict breccia 801 with two lithologies: Galim (a) is a heavily-shocked LL6 chondrite and Galim (b) an 802 impact melt breccia. Kota Kota (EH3) displays a strong enrichment in LREE. B) EH4 803 and EH5. Abee (EH4) is enriched in REE compared to other samples from the EH4 804 and EH5 groups. C) EL3 and one meteorite from the EL5 subgroup (Adrar Bous). 805 MAC 88180 (two dissolutions) has two patterns that are both strongly enriched. 806 Almahata Sitta MS-177 has the lowest REE contents. D) EL6 meteorites. All EL6 807 samples present very similar REE patterns, except EET 92063 described as highly 808 weathered and classified in an anomalous EL6 by Barrat et al. (2014).

809

Figure. 2. $(La/Sm)_N$ normalized to CI chondrites using the values of Anders and Grevesse, (1989) compared with Yb contents (in ppm) for EC samples. Data are from this study and literature data from Gannoun et al. (2011b), Barrat et al. (2014) and Kalleymen and Wasson (1986). IM: impact melt.

Figure. 3. Compilation of $\mu^{142}Nd$ values (in ppm) in carbonaceous, ordinary and 815 816 enstatite chondrites. For each individual data point, errors bars show internal errors 817 (i.e. in-run errors, 2SE) or 2SD when several replicates of the same sample were 818 measured. Vertical pale yellow bands represent the mean of each chondrite groups 819 ±2SD and vertical green bands represent 95% confidence intervals. A) Measured $\mu^{142}\text{Nd}$ expressed in part per million (ppm) deviations relative to the measured 820 standard values. B) μ^{142} Nd normalized to the CHUR 147 Sm/ 144 Nd following the 821 correction method A. C) μ^{142} Nd normalized to the CHUR 147 Sm/ 144 Nd value 822 823 following the correction method B. See Figure 5 and text for further details. Literature 824 data are from: Boyet and Carlson (2005); Andreasen and Sharma (2006); Carlson et 825 al. (2007); Gannoun et al. (2011a); Bouvier and Bovet (2016); Burkhardt et al. 826 (2016); Fukai and Yokohama (2017); and this study for Almahata Sitta MS-177. All 827 values are shown but six samples were removed from calculated weighted averages 828 reported in the figure caption for their respective groups because they have either 829 highly fractionated Sm/Nd ratios (Tagish Lake, NWA 2090, Adrian, Kota Kota and 830 Blithfiled) or correspond to a single run with a large internal uncertainty meaning that 831 the measurement is not reliable (Abee). Weighted mean values for CC are: -33 (\pm 16, \pm 4 for 2SD and 95% confidence interval, respectively); -32 (\pm 13; \pm 3), -32 (\pm 13; \pm 832 3) in graphs A, B and C. Weighted mean values for OC are: $-16 (\pm 9, \pm 2)$; $-15 (\pm 9;$ 833 834 \pm 2), -16 (\pm 9; \pm 2) in graphs A, B and C. Weighted mean values for EC are: -11 (\pm 12, \pm 2); -9 (\pm 15; \pm 3), -10 (\pm 12; \pm 2) in graphs A, B and C. Number of 835 836 measurements is 20 (10 samples) for CC, 28 (24 samples) for OC and 29 (17 samples) 837 for EC. Individual values and calculations (averages, errors) are reported in Table S1. 838

Figure 4. A. Compilation of measured μ^{142} Nd vs. ¹⁴⁷Sm/¹⁴⁴Nd for the different chondrite samples. The line corresponds to a slope for a 4.568 Ga isochron. Here the line is forced through the mean value of the ordinary chondrites group. B. Histogram showing the distribution of measured ¹⁴⁷Sm/¹⁴⁴Nd ratios in the different groups of chondrites. C. Comparison of the μ^{142} Nd normalized to the chondritic evolution following the two calculation methods (A vs B) explained in the main text and shown schematically in Figure 5. D. Same diagram as C for EC samples only.

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Figure 5. Schematic illustration of the correction method for the normalization of ¹⁴²Nd/¹⁴⁴Nd ratios to a common chondritic evolution. A. Method A using the measured ¹⁴⁷Sm/¹⁴⁴Nd ratio of the sample. B. Method B using the calculated Sm/Nd ratio from the long-lived ¹⁴⁷Sm-¹⁴³Nd systematics. T₀ is the age of the Solar System formation, i.e. 4.568 Ga (Bouvier and Wadhwa, 2010). More details can be found in the text. The CHUR parameters are those defined by Bouvier et al. (2008).

855 Figure 6. A. Mass independent stable Nd isotope composition of enstatite chondrites μ^{142} Nd corr. B vs μ^{148} Nd; B. μ^{145} Nd vs μ^{148} Nd; C. μ^{145} Nd vs μ^{150} Nd. Average values 856 ± 2 SD (all in ppm) for CC are -32 ± 13 (μ^{142} Nd), 4 ± 19 (μ^{145} Nd), 16 ± 27 (μ^{148} Nd) 857 and $17 \pm 68 \ (\mu^{150} \text{Nd})$. For OC: $-15 \pm 9 \ (\mu^{142} \text{Nd})$, $3 \pm 15 \ (\mu^{145} \text{Nd})$, $7 \pm 15 \ (\mu^{148} \text{Nd})$ and 858 14 ± 54 (μ^{150} Nd). CC data include 20 measurements on 10 samples. For OC, a total of 859 860 29 measurements carried out on 25 different samples are considered. For comparison, 861 the average values obtained from OC data published in Burkhardt et al. (2016) are - $18\pm6 \ (\mu^{142}Nd), 6\pm9 \ (\mu^{145}Nd), 7\pm8 \ (\mu^{148}Nd) and 17\pm13 \ (\mu^{150}Nd) \ (all in ppm).$ Dashed 862 lines (long and short respectively) represent mixing of the s-model prediction with the 863

terrestrial composition following: 1) stellar model by Arlandini et al. (1999), and 2)
using the composition of SiC as representative of a pure s-process component (Hopp
and Ott, 1997). External reprodubilities are not provided because this compilation
includes data obtained by different authors and using different techniques.

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Figure 7. Corrected μ^{142} Nd (normalized to the chondritic evolution using method B) in enstatite chondrites. Samples are ordered by groups. Fall meteorite samples are shown in bold.

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Table 1. Rare Earth element contents of enstatite chondrites measured by ICP-MS.
Two methods of acid digestion were used: (A) in PFA Savillex® beakers on hot plate
at atmospheric pressure, (b) into individual pressurized Parr® bombs.

879

880 Table 2. Measured Nd isotope composition of the JNdi-1 standard and MS-177 (EL3). Errors correspond to the external reproducibility for the JNdi-1 standard runs 881 (2SD) and internal error for MS-177. ¹⁴⁷Sm/¹⁴⁴Nd ratio has been measured by isotope 882 dilution. The initial ε^{143} Nd is calculated at 4.568 Ga using the CHUR parameters 883 884 defined by Bouvier et al. (2008). The average values measured for the terrestrial standard (n=7) are 1.141850 \pm 6 for ¹⁴²Nd/¹⁴⁴Nd, 0.512111 \pm 4 for ¹⁴³Nd/¹⁴⁴Nd, 885 0.348403 ± 2 for ¹⁴⁵Nd/¹⁴⁴Nd, 0.241578 ± 2 ¹⁴⁸Nd/¹⁴⁴Nd, and 0.236446 ± 3 for 886 ¹⁵⁰Nd/¹⁴⁴Nd (see details in Table S2). 887

Table 1.

Rare Earth Elements measured in enstatite chondrites by ICP-MS

* Results already published in Gannoun et al. (2011b)

Dissolution A) in PFA Savillex® beakers on hot plate at atmospheric pressure, B) into individual pressurized Parr® bombs.

^a mass of the aliquot uptaken for measuring REE that corresponds to 5% of the total dissolution

sample name	ALHA 77295*	Sahara 97072*	Sahara 97096*	Sahara 97158*	Kota Kota	Abee	Indarch	St Mark's	MAC 02837	MAC 02839	MAC 88180	MAC 88180	MS-177	Adrar Bous	Eagle	Hvittis	Hvittis	Hvittis	Hvittis	Khairpur
type	EH3	EH3	EH3	EH3	EH3	EH4	EH4	EH5	EL3	EL3	EL3	EL3	EL3	EL5	EL6	EL6	EL6	EL6	EL6	EL6
Fall						Х	Х	Х					Х		Х	Х	Х	Х	Х	X
weight (g)	0.05	0.05	0.05	0.05	0.05	0.16	0.05	0.05	0.05	0.05	0.12	0.13	0.08ª	0.11	0.05	0.12	0.10	0.10	0.05ª	0.05
dissolution #	Α	А	А	А	А	В	А	А	А	А	А	В	В	В	А	А	А	А	В	A
La	0.247	0.233	0.237	0.231	0.506	0.274	0.222	0.215	0.247	0.265	0.449	0.432	0.156	0.192	0.189	0.141	0.136	0.181	0.250	0.175
Ce	0.556	0.545	0.590	0.542	1.235	0.721	0.555	0.542	0.616	0.663	1.174	1.113	0.379	0.488	0.509	0.392	0.350	0.487	0.677	0.457
Pr	0.087	0.086	0.093	0.087	0.162	0.110	0.089	0.086	0.097	0.103	0.176	0.169	0.056	0.075	0.084	0.062	0.063	0.077	0.107	0.074
Nd	0.423	0.438	0.455	0.435	0.749	0.557	0.433	0.416	0.480	0.530	0.895	0.847	0.290	0.381	0.442	0.326	0.326	0.401	0.571	0.374
Sm	0.144	0.123	0.146	0.132	0.207	0.183	0.144	0.134	0.158	0.168	0.307	0.278	0.096	0.121	0.136	0.112	0.111	0.137	0.193	0.124
Eu	0.053	0.049	0.054	0.049	0.071	0.059	0.053	0.052	0.058	0.062	0.080	0.076	0.054	0.060	0.047	0.045	0.044	0.048	0.058	0.050
Gd	0.205	0.188	0.209	0.191	0.269	0.256	0.204	0.196	0.226	0.243	0.390	0.374	0.133	0.177	0.212	0.160	0.165	0.196	0.264	0.179
Tb	0.035	0.034	0.037	0.033	0.044	0.045	0.035	0.035	0.038	0.041	0.073	0.069	0.025	0.030	0.036	0.029	0.028	0.035	0.049	0.031
Dy	0.244	0.250	0.257	0.232	0.301	0.317	0.245	0.236	0.268	0.295	0.474	0.449	0.174	0.208	0.254	0.201	0.207	0.243	0.337	0.221
Ho	0.054	0.053	0.057	0.051	0.063	0.069	0.054	0.051	0.059	0.064	0.103	0.097	0.039	0.047	0.058	0.044	0.045	0.052	0.073	0.050
Er	0.161	0.160	0.172	0.156	0.189	0.201	0.160	0.154	0.174	0.194	0.306	0.294	0.120	0.142	0.174	0.139	0.142	0.160	0.218	0.147
Tm	0.023	0.022	0.027	0.023	0.028	0.030	0.025	0.023	0.026	0.029	0.047	0.045	0.018	0.021	0.027	0.022	0.023	0.025	0.032	0.023
Yb	0.155	0.150	0.174	0.144	0.183	0.196	0.162	0.155	0.182	0.194	0.323	0.307	0.117	0.150	0.187	0.152	0.155	0.177	0.202	0.157
Lu	0.024	0.022	0.026	0.024	0.028	0.030	0.025	0.023	0.026	0.028	0.048	0.045	0.021	0.024	0.029	0.023	0.023	0.028	0.033	0.024

Table 2

	JNdi-1	MS-177
I ¹⁴⁵ Nd (V)	0.7 - 1.5	0.64
μ^{142} Nd	0.0 ± 5.6	-10.9 ± 5.7
μ^{143} Nd	0.0 ± 7.4	640 ± 4.9
μ ¹⁴⁵ Nd	0.0 ± 4.4	5.7 ± 4.1
μ ¹⁴⁸ Nd	0.0 ± 8.2	9.9 ± 7.4
μ ¹⁵⁰ Nd	0.0 ± 10.9	11.5 ± 11.5
¹⁴² Ce ppm	0.4	1.2
¹⁴⁴ Sm ppm	0.4	0.3
n	6	1
¹⁴⁷ Sm/ ¹⁴⁴ Nd		0.1896
μ^{142} Nd A		-1.4
μ ¹⁴² Nd B		-1.1
ε ¹⁴³ Nd, 4.568 G	ia	0.06

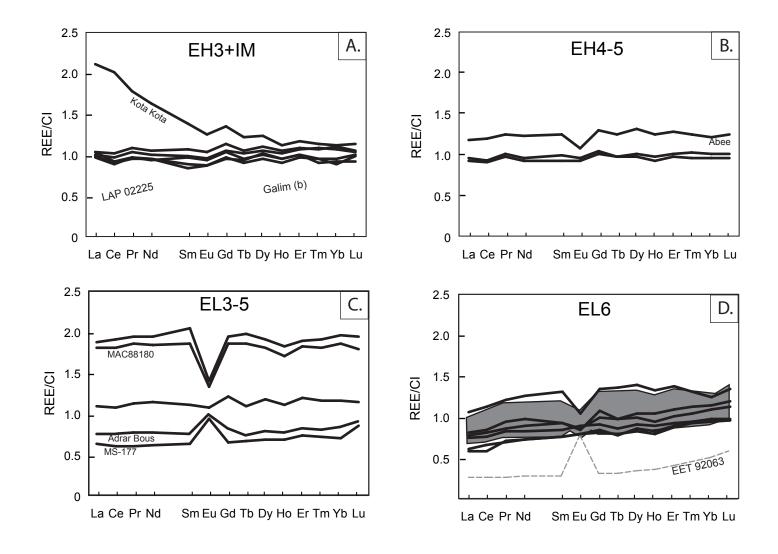


Figure 1

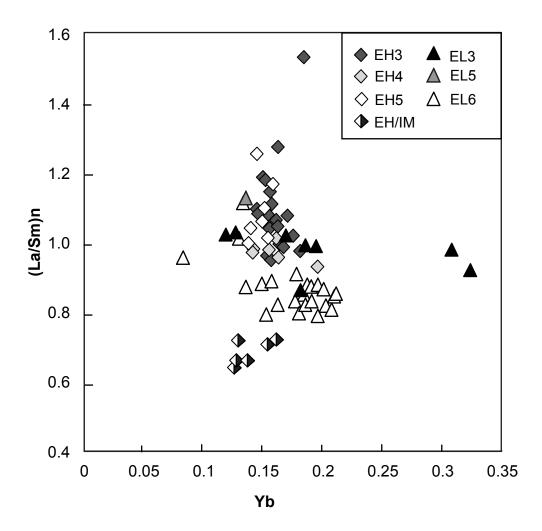


Figure 2.

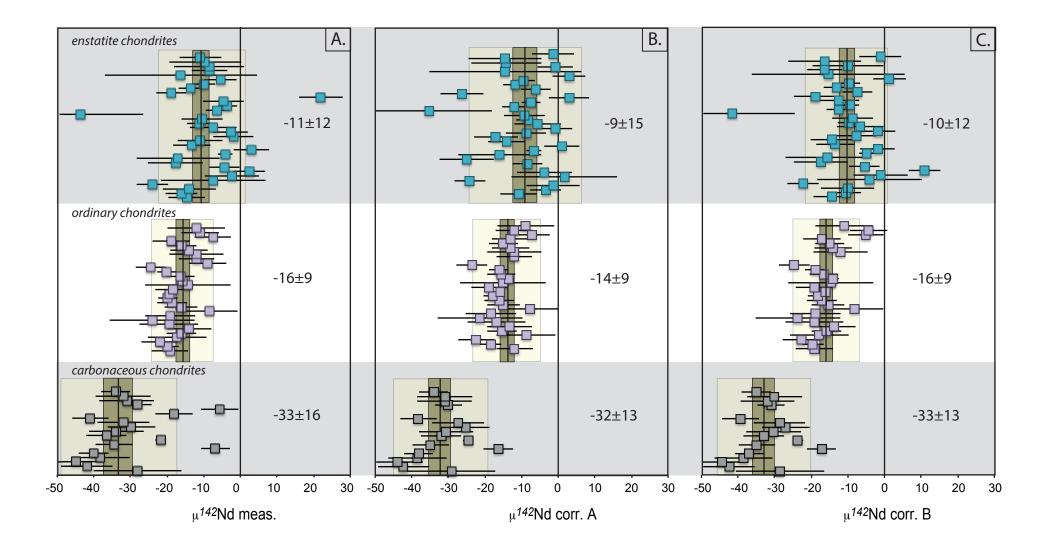


Figure 3.

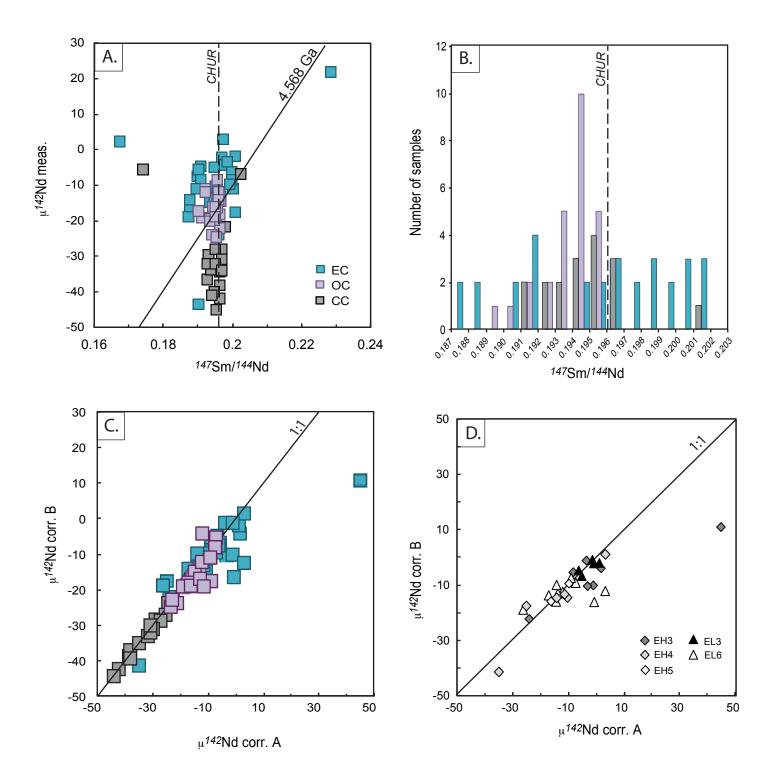


Figure 4

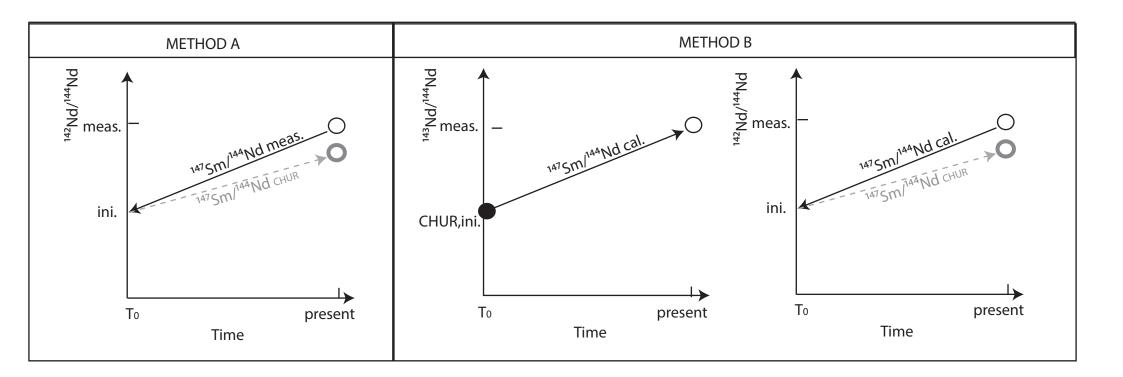


Figure 5

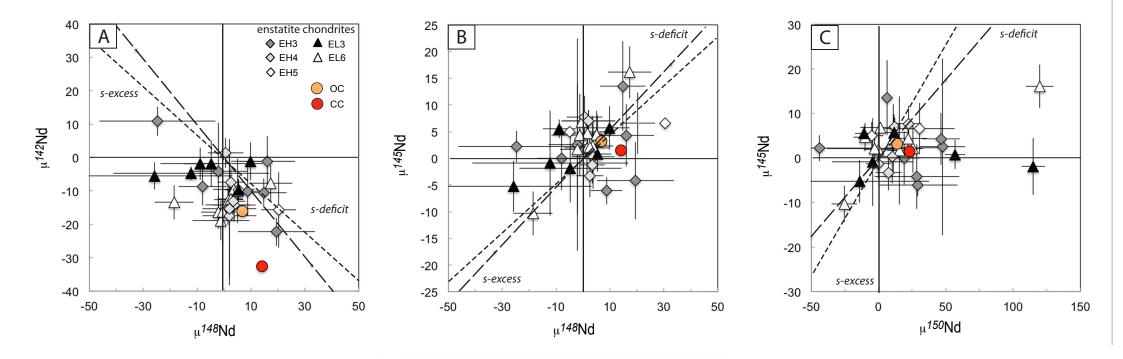


Figure 6.

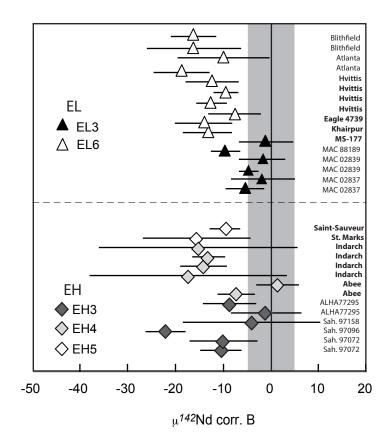


Figure 7

Table S1. Compilation from: Boyet and Carlson 2005 Rankenburg et al., 2006 Carlson et al., 2007 Gannoun et al., 2011 Bouvier and Boyet 2016 Fukial and Yokoyama 2017

Name	Туре	μ ¹⁴² Nd	μ ^{sea} Nd	µ ¹⁶⁵ Nd	μ ^{sek} Nd	µ ¹⁵⁰ Nd	2S* به ¹⁴² Nd	2S* µ ¹⁶³ Nd	2S* μ ^{sti} Nd	2S* μ ^{see} Nd	2S* μ ¹⁵⁰ Nd	µ ^{st2} Nd corr A	u142 corr B	⁵⁶⁷ Sm/ ⁵⁶⁶ Nd	Reference
Carbonaceous chondrites															
Orgueil Cold Bokkveld	CI-Fall CM2-Fall	-28.0 -41.9	1000.7 1001.7	-25.3 2.6	4.1 25.7	1.3 42.3	12.0 7.0	5.0 5.0	13.0 7.0	20.0 12.0	28.0 17.0	-29.2 -42.2	-28.5 -42.4	0.1968 0.1962	Carlson et al., Science 2007 Carlson et al., Science 2007
Mighei Murray	CM2-Fall CM2-Fall	-45.0 -38.2	960.5 997.2	8.0 4.9	50.5 28.6	88.8 29.2	7.0 8.0	5.0 5.0	7.0 8.0	13.0 15.0	18.0 19.0	-44.0 -38.5	-44.4 -38.5	0.1953 0.1962	Carlson et al., Science 2007 Carlson et al., Science 2007
Allende	CV3-Fall	-40.0	858.8	13.2	30.2	26.2	4.0	5.0	5.0	8.0	11.0	-38.1	-36.9	0.1947	Carlson et al., Science 2007
Grosnaja Mokoia	CV3-Fall CV3-Fall	-6.8 -34.4	1396.1 1001.3	-12.1	7.9 21.9	18.2 39.8	4.0 5.0	5.0 5.0	4.0 5.0	6.0 8.0	10.0	-16.3 -34.9	-17.2 -34.9	0.2024 0.1963	Carlson et al., Science 2007 Carlson et al., Science 2007
Allende Allende	CV3-Fall CV3-Fall	-21.8 -36.6	1101.2 889.3	-1.8 4.0	8.7 7.3	14.1 4.8	1.5 5.5	6.7 4.5	15.4 3.8	19.9 7.2	32.5 10.3	-24.6 -32.0	-23.6 -32.9	0.1979 0.1930	Gannoun et al., PNAS 2011 Boyet and Carlson 2005
Allende Allende Bomb	CV3-Fall CV3-Fall	-33.9 -29.7	891.8 924.4	4.4 0.3	-2.3 -6.3	-20.7 -27.9	7.5 6.5	6.3 5.4	5.4 4.5	9.6 8.2	13.3 10.9	-30.6 -25.3	-30.3 -27.0	0.1938 0.1929	Boyet and Carlson 2005 Boyet and Carlson 2005
Allende	CV3-Fall	-32.0	904.2	1.6	1.0	-12.5	7.1	5.6	5.4	9.8	13.2	-27.4	-28.7	0.1941	Boyet and Carlson 2005
Allende Allende (2)	CV3-Fall CV3-Fall	-41.0 -30.0	966.6 1076.2	3.0 2.0	6.0 9.0	118.0 8.0	5.0 5.0	0.0	9.0	4.0	24.0	-38.2 -30.0	-39.3 -31.0	0.1941	Rankenburg et al., 2006 Burkhardt et al. (2016)
Allende (3) Allende (4)	CV3-Fall CV3-Fall	-30.0 -33.0	1088.4 1000.6	5.0 8.0	4.0 16.0	-6.0 11.0	6.0 8.0	3.1 2.6	6.0 13.0	7.0 15.0	24.0 31.0	-31.0 -31.0	-32.0 -33.0		Burkhardt et al. (2016) Burkhardt et al. (2016)
Dho 1432 Murchison	CR2-Found CM2-Fall	-28.0 -31.0		16.0 2.1	18.0 23.0	26.0 24.0	3.8 7.4		15.0 16.0	5.4 13.0	9.5 24.0	-26.0 -32.0	-30.0 -31.0	0.195	Fukai and Yokoyama 2017 Fukai and Yokoyama 2017
Allende	CV3-Fall CO3-Found	-32.0		-1.1	19.0	27.0	7.5		16.0	16.0	26.0	-30.0	-31.0	0.195	Fukai and Yokoyama 2017
DaG 190 Tagish Lake	C2-ungrouped-Fall	-34.0 -18.0		19.0 -4.9	22.0 3.2	27.0 8.7	4.0 5.1		27.0 16.0	4.6 5.9	7.4 11.0	-35.0	-34.0	0.197 0.148	Fukai and Yokoyama 2017 Fukai and Yokoyama 2017
NWA 2090	CO3-Fall	-5.6		-6.7	0.8	4.3	5.1		48.0	5.9	11.0			0.174	Fukai and Yokoyama 2017
Ordinary chondrites															
Gladstone Homestead	H6-Find L5-Fall	-19.2 -19.8	982.6 974.4	2.9	3.3 8.7	9.3 12.7	5.0 3.0		6.0 3.0	11.0 6.0	14.0 8.0	-11.9 -18.5	-19.2	0.1911 0.1951	Carlson et al., Science 2007 Carlson et al., Science 2007
Ucera	HS-Fall	-22.0	1013.0	-2.0 -2.6	21.1	122.6	5.0		6.0	10.0	13.0	-22.4	-19.6 -22.7	0.1963	Carlson et al., Science 2007
Peace River Sharps	L6-Fall H3-Fall	-17.3 -16.2	1004.4 1024.9	22.1 8.5	0.4	26.2 -13.3	8.0 4.1	3.3	9.0 3.1	14.0 5.0	19.0 7.7	-8.8 -15.4	-17.8 -15.9	0.1903 0.1959	Carlson et al., Science 2007 Boyet and Carlson 2005
Sharps Richardton (Bomb)	H3-Fall H5-Fall	-13.9 -19.5	1033.7 1020.9	7.2 3.6	-2.4 8.7	-13.2 -29.7	6.1 8.0	5.2 6.5	4.5 6.1	8.1 11.3	11.5 14.8	-13.2 -16.9	-13.9 -19.2	0.1951 0.1942	Boyet and Carlson 2005 Boyet and Carlson 2005
Richardton Dhaiala	HS-Fall H3-Fall	-24.0	1020.9	3.1 3.9	22.9	-19.4	11.6 6.9	9.3 5.6	9.2 4.8	16.7 8.2	21.6 12.1	-21.4	-23.7 -18.9	0.1942	Boyet and Carlson 2005
Bruderheim	L6-Fall	-8.5	1020.2	2.8	-16.3	-27.3	7.7	6.3	5.8	10.6	13.9	-7.7	-8.1	0.1955	Boyet and Carlson 2005 Boyet and Carlson 2005
Allegan Forest City	HS-Fall HS-Fall	-16.1 -18.6	1005.9 974.9	5.2 5.2	11.3 3.6	25.1 7.3	4.5 4.1	3.9 9.4	4.9 7.3	6.2 14.6	11.8 37.1	-15.0 -16.2	-15.4 -17.0	0.1952 0.1944	Burkhardt et al., 2016 Burkhardt et al., 2016
Queens Mercy Bruderheim	H6-Fall L6-Fall	-19.8 -19.4	971.3 904.6	1.9	6.1 0.9	16.0 11.8	2.7	2.5	2.8	15.8 15.2	46.1 49.6	-17.7	-18.2	0.1946	Burkhardt et al., 2016 Burkhardt et al., 2016
Chelyabinsk	LLS-Fall	-18.3	1068.6	2.4	2.6	7.6	5.0	7.7	0.8	9.4	1.8	-18.8	-19.2	0.1963	Burkhardt et al., 2016
Dhurmsala Farmington	LLG-Fall LS-Fall	-14.3 -15.9	1048.8 945.2	0.2 9.6	9.2 9.8	21.9 23.8	11.6 1.5	7.5 4.4	8.5 8.1	4.7 6.4	25.7 4.2	-15.1 -13.5	-14.6 -14.0	0.1965	Burkhardt et al., 2016 Burkhardt et al., 2016
Ste. Marguerite Pultusk	H4-Fall H5-Fall	-16.3 -20.1	1031.8 975.2	9.6 12.9	11.1 10.7	23.8 21.2 18.2	3.9	0.5 7.5	4.2 7.3	2.7	4.2 13.4 19.1	-15.6 -16.2	-16.6	0.1955 0.1934	Burkhardt et al., 2016 Burkhardt et al., 2016 Burkhardt et al., 2016
Ste. Marguerite (2)	H4-Fall	-24.4	975.2 1029.2	10.1	6.4	17.5	4.2	7.5 14.9	15.0	17.6	0.6	-16.2 -23.5	-24.7	0.1934 0.1954	Burkhardt et al., 2016
Kesen Forest City	H4-Fall H5-Fall	-12.0 -12.0		-4.4 17.0	15.0 11.0	27.0 17.0	4.9 7.4		14.0 27.0	4.9 7.6	12.0 19.0	-12.0	-12.0 -12.0	0.196	Fukai and Yokoyama 2017 Fukai and Yokoyama 2017
Saratov	L4-Fall L5-Found	-14.0		6.8	13.0	20.0	5.1 4.0		16.0 27.0	5.9 4.6	11.0	-14.0	-13.0	0.196	Fukai and Yokoyama 2017 Fukai and Yokoyama 2017
Etter Modoc (1905)	L6-Fall	-19.0		-6.1	8.9 8.1	6.0	5.1		16.0	5.9	11.0	-17.0	-13.0	0.195	Fukai and Yokoyama 2017
Hamlet Tuxtuac	LL4-Fall LL5-Fall	-7.5 -11.0		2.4 -7.3	10.0 6.4	35.0 13.0	4.9 5.1		15.0 16.0	5.1 5.9	12.0 11.0	-5.1 -4.3	-7.2 -12.0	0.192	Fukai and Yokoyama 2017 Fukai and Yokoyama 2017
Saint-Séverin	LLS-Fall LL6-Fall H4-Found	-11.0 -12.0 -8.9		-7.3 -5.7 -7.5	6.4 10.0 -1.0	23.0 -1.7	5.1 7.8 5.1		16.0 14.0 16.0	5.9 12.0 5.9	11.0 12.0 11.0	-4.3	-12.0	0.192 0.192 0.1370	Fukai and Yokoyama 2017
Adrian	n++Found	-8.9		-7.5	-1.0	-1./	3.1		10.0	3.9	11.0			0.1370	Fukai and Yokoyama 2017
Enstatite chondrites															
Indarch SAHARA 97072	EH4-Fall EH3-Found	-14.6 -16.1	969.7 808.7	0.3 13.5	3.7 14.7	10.2 6.4	5.0 4.3	3.5	6.0 8.4	8.0 8.4	11.0 3.1	-10.8 -3.4	-14.3 -10.6	0.1934 0.1875	Carlson et al., Science 2007 Gannoun et al., PNAS 2011
SAHARA 97072	EH3-Found	-14.0	872.6	-6.1	8.8	29.2	7.3	2.2	2.5	5.8	29.4	-1.3	-10.1	0.1875	Gannoun et al., PNAS 2011
SAHARA 97096 SAHARA 97158	EH3-Found EH3-Found	-24.0 -7.4	957.3 895.1	-4.2 2.5	19.5 -2.0	28.5 47.5	4.3 14.4	6.3 17.7	7.2 19.9	14.3 10.7	31.5 17.0	-24.1 1.7	-22.2 -4.1	0.1961 0.1899	Gannoun et al., PNAS 2011 Gannoun et al., PNAS 2011
ALHA77295 MAC 02837	EH3-Found EH3-Found	-2.3 -4.4	982.0 1071.7	4.3 -5.3	16.1 -25.8	46.4	7.4 4.1	6.3 0.7	5.8 4.8	10.4 29.0	14.1 51.8	-3.7 -8.4	-1.1 -5.5	0.1970	Gannoun et al., PNAS 2011 Gannoun et al., PNAS 2011
Indarch	EH4-Fall	-17.7	1014.9	2.0	0.7	4.3	7.4	12.5	6.4	0.0	36.6	-25.0	-17.4	0.2009	Gannoun et al., PNAS 2011
St. Mark's MAC 02839	EH5-Fall EL3-Found	-17.0 -4.2	974.3 1049.3	6.6 -0.9	20.3	30.4 -4.3	11.3 2.1	9.9 4.8	5.8 9.9	6.5 29.0	26.2 30.4	-16.0 -6.6	-15.7 -4.8	0.1953 0.1976	Gannoun et al., PNAS 2011 Gannoun et al., PNAS 2011
MAC 88180	EL3-Found EL6-Fall	3.1	1224.7 1034.1	5.5	-8.8	-10.8	4.8	4.1	1.7	6.2 7.2	6.9	1.0 -14.0	-1.9	0.1974	Gannoun et al., PNAS 2011 Gannoun et al., PNAS 2011
Khairpur Eagle	EL6-Fall	-13.2 -10.9	1156.1	-10.3 1.9	-18.5 1.5	-25.4 0.1	5.1 6.0	4.4 5.0	4.1 4.7	8.3	9.5 11.2	-17.0	-13.4 -14.2	0.1965 0.2001	Gannoun et al., PNAS 2011
Hvittis MAC 02837	EL6-Fall EL3-Found	-1.8 -5.0	1261.7 999.4	16.1 -1.9	17.3 -4.7	119.8 115.0	5.5 6.8	4.9 2.7	4.9 6.4	8.1 19.0	10.2 8.6	-8.8 -0.8	-7.7 -1.8	0.2007 0.1948	Gannoun et al., PNAS 2011 Bouvier and Boyet 2016
MAC 02339	EL3-Found	-11.4	960.5	0.8	5.4	56.9	3.2	3.9	3.3	5.2	7.6	-8.2	-9.6	0.1939	Bouvier and Boyet 2016
ALHA 77295 Hvittis (1)	EH3-Found EL6-Fall	-10.4 -6.3	963.7 1285.4	0.0 4.7	-7.9 1.7	19.0 -10.0	5.6 3.2	6.5 2.7	5.9 3.2	9.0 5.4	11.8 8.5	-9.1 -12.1	-8.7 -12.6	0.1951 0.1999	Bouvier and Boyet 2016 Burkhardt et al., 2016
Hvittis (2) Atlanta	EL6-Fall FL6-Fall	-3.5 -4.6	1262.7 1332.1	2.3 2.1	3.6 2.5	25.6 -2.9	2.6 5.5	3.1 7.3	5.6	7.7 4.6	21.4 35.7	-7.4 2.9	-9.5 -12.4	0.1986	Burkhardt et al., 2016 Burkhardt et al., 2016
Abee (1)	EH4-Fall					7.6	4.0	3.1	4.0	5.0	9.7	-6.1	-7.4		
		-18.9	562.5	-3.3	2.6									0.1874	Burkhardt et al., 2016
Indarch Saint-Sauveur	EH4-Fall EH5-Fall	-13.5	562.5 1006.2 1023.7	-3.3 -1.3	2.6 3.4 5.5	0.0	3.4	2.9 2.5	3.4 3.2	4.6 5.0	9.3 8.5	-11.8	-13.1	0.1874 0.1948 0.1956	Burkhardt et al., 2016
Saint-Sauveur Abee (2)	EH4-Fall EH5-Fall EH4-Fall	-13.5 -10.0 -5.5	1006.2 1023.7 745.3	-3.3 -1.3 5.0 7.7	3.4 5.5 0.6	0.0 -4.9 22.4	3.4 3.2 4.5	2.5 3.1	3.2 4.0	5.0 6.6	8.5 9.7	-11.8 -9.4 3.0	-13.1 -9.7 1.4	0.1948 0.1956 0.1903	Burkhardt et al., 2016 Burkhardt et al., 2016 Burkhardt et al., 2016
Saint-Sauveur Abee (2) Indarch (2) Atlanta (2)	EH4-Fall EH5-Fall EH4-Fall EH4-Fall EL6-Found	-13.5 -10.0 -5.5 -16.3 -8.4	1006.2 1023.7 745.3 981.2 1334.5	-3.3 -1.3 5.0 7.7 7.0 1.7	3.4 5.5 0.6 2.0 -2.1	0.0 -4.9 22.4 12.0 15.4	3.4 3.2 4.5 20.8 4.8	2.5 3.1 6.6 8.6	3.2 4.0 2.0 12.2	5.0 6.6 10.0 6.4	8.5 9.7 3.0 9.0	-11.8 -9.4 3.0 -14.5 -0.8	-13.1 -9.7 1.4 -15.3 -16.3	0.1948 0.1956 0.1903 0.1948 0.1909	Burkhardt et al., 2016 Burkhardt et al., 2016 Burkhardt et al., 2016 Burkhardt et al., 2016 Burkhardt et al., 2016
Saint-Sauveur Abee (2) Indarch (2) Atlanta (2) Blithfield (2)	EH4-Fall EH5-Fall EH4-Fall EH4-Fall EL6-Found EL6-Found	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5	1006.2 1023.7 745.3 981.2 1334.5 1075.3	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4	3.4 5.5 0.6 2.0 -2.1 5.1	0.0 -4.9 22.4 12.0 15.4 22.0	3.4 3.2 4.5 20.8 4.8 9.7	2.5 3.1 6.6 8.6 0.0	3.2 4.0 2.0 12.2 4.5	5.0 6.6 10.0 6.4 2.3	8.5 9.7 3.0 9.0 14.4	-11.8 -9.4 3.0 -14.5 -0.8 -14.2	-13.1 -9.7 1.4 -15.3 -16.3 -10.0	0.1948 0.1956 0.1903 0.1948 0.1909 0.1998	Burkhardt et al., 2016 Burkhardt et al., 2016
Saint-Sauveur Abee (2) Indarch (2) Atlanta (2) Blithfield (2) Hvittis (3) MS-177	EH4-Fall EH5-Fall EH4-Fall EH4-Fall EL6-Found EL6-Fall EL3-Fall	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0	-3.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7	2.5 3.1 6.6 8.6 0.0 0.6 4.9	3.2 4.0 2.0 12.2 4.5 0.0 4.1	5.0 6.6 10.0 6.4 2.3 0.6 7.4	8.5 9.7 3.0 9.0 14.4 15.0 11.5	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -1.4	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1	0.1948 0.1956 0.1903 0.1948 0.1909 0.1998 0.1993 0.1993	Burkhardt et al., 2016 Burkhardt et al., 2016 This study
Saint-Sauveur Abee (2) Indarch (2) Atlanta (2) Blithfield (2) Hvittis (3) MS-177 Abee Kota-Kota	EH4-Fall EH5-Fall EH4-Fall EH4-Fall EL6-Found EL6-Found EL6-Fall EL4-Fall EH4-Fall EH4-Fall	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 -31.4 -24.7	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9 -44.0	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1	3.2 4.0 2.0 12.2 4.5 0.0 4.1 17.4 2.9	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -1.4 -35.1 44.7	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1 -41.5 10.9	0.1948 0.1956 0.1903 0.1948 0.1909 0.1998 0.1993 0.1896 0.1903 0.1675	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Sauveur Abee (2) Indarch (2) Atlanta (2) Blithfield (2) Hvittis (3) MS-177 Abee	EH4-Fall EH5-Fall EH4-Fall EH4-Fall EL6-Found EL6-Fall EL3-Fall EH4-Fall EH4-Fall EH4-Fall EH4-Found	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 22.0	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 -31.4 -24.7 -1.1	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3	3.2 4.0 2.0 12.2 4.5 0.0 4.1 17.4	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -1.4 -35.1	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1 -41.5	0.1948 0.1956 0.1903 0.1948 0.1909 0.1998 0.1993 0.1896 0.1903	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005
Saint-Sauveur Abee (2) Indarch (2) Atlanta (2) Blithfield (2) Hvittis (3) MS-177 Abee Kota-Kota Blithfield (1)	EH4-Fall EH5-Fall EH4-Fall EH4-Fall EL6-Found EL6-Fall EL3-Fall EH4-Fall EH4-Fall EH4-Fall EH4-Found	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 22.0	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 -31.4 -24.7 -1.1	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9 -44.0 10.9	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -1.4 -35.1 44.7	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1 -41.5 10.9	0.1948 0.1956 0.1903 0.1948 0.1909 0.1998 0.1993 0.1896 0.1903 0.1675	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Sauveur Aber (2) Indurch (2) Allanta (2) Bilthfield (2) Hvittis (3) MS-177 Abee Kota-Kota Bilthfield (1) *Uncertainties on individua Carbonaceous Chondrites ALL	EH4-Fall EH4-Fall EH4-Fall EL6-Found EL6-Found EL6-Fall EH4-fall EH4-fall EH4-fall EH4-fall EH4-found EL6-Found	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 22.0 al errors (2	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3 errnal error	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 -31.4 -24.7 -1.1 s (2SD) wh	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9 -44.0 10.9 men severa	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -1.4 -35.1 44.7 -26.2	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1 -41.5 10.9 -18.8	0.1948 0.1956 0.1903 0.1948 0.1909 0.1998 0.1993 0.1896 0.1903 0.1675 0.2285	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Sauveur Abee (2) Indarch (2) Atlanta (2) Bilinthield (2) Hvittis (3) MS-177 Abee Kota-Kota Bilinthield (1) *Uncertainties on individua Carbonaceous Chondrites	EH4-Fall EH4-Fall EH4-Fall EH4-Fall EL6-Found EL6-Found EL6-Found EL3-Fall EH3-Found EL6-Found EL6-Found EL6-Found Manples are interna	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 22.0 al errors (2 -30.5 -31.4	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3 errnal error 2.0 1.4	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 -31.4 -24.7 -1.1 s (2SD) wf	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9 -44.0 10.9 ten severa	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -1.4 -35.1 44.7 -26.2 -31.8 -23.4	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1 -41.5 10.9 -18.8 -32.3 -23.7	0.1948 0.1956 0.1903 0.1948 0.1999 0.1998 0.1993 0.1896 0.1903 0.1675 0.2285	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Sauveur Aber (2) Indurch (2) Allanta (2) Bilthfield (2) Hvittis (3) MS-177 Abee Kota-Kota Bilthfield (1) *Uncertainties on individua Carbonaceous Chondrites ALL	EH4-Fall EH5-Fall EH4-Fall EL6-Found EL6-Found EL6-Found EL6-Found EL6-Fall EL3-Fall EH3-Found Isamples are interna isamples are interna sean sean S250	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 22.0 al errors (2 -30.5 -31.4 20.1	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3 errnal error 2.0 1.4 18.5	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 -31.4 -24.7 -1.1 s (2SD) wf	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9 -44.0 10.9 ten severa 20.5 16.1 65.3	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -1.4 -35.1 44.7 -26.2 -31.8 -23.4 13.0	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1 -41.5 10.9 -18.8 -32.3 -23.7 12.5	0.1948 0.1956 0.1903 0.1948 0.1909 0.1998 0.1993 0.1896 0.1903 0.1675 0.2285	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Sauveur Aber (2) Indurch (2) Allanta (2) Bilthfield (2) Hvittis (3) MS-177 Abee Kota-Kota Bilthfield (1) *Uncertainties on individua Carbonaceous Chondrites ALL	EH4-Fall EH4-Fall EH4-Fall EH4-Fall EL6-Found EL6-Found EL6-Found EL3-Fall EH3-Found EL6-Found EL6-Found EL6-Found Manples are interna	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 22.0 al errors (2 -30.5 -31.4	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3 errnal error 2.0 1.4	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 -31.4 -24.7 -1.1 s (2SD) wf	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9 -44.0 10.9 10.9 10.9 10.9 10.9 10.9 10.5 16.1 65.3 14.5 13.9	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -1.4 -35.1 44.7 -26.2 -31.8 -23.4	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1 -41.5 10.9 -18.8 -32.3 -23.7	0.1948 0.1950 0.1903 0.1903 0.1909 0.1909 0.1998 0.1998 0.1998 0.1993 0.1895 0.2285 0.1220 0.2285	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Sauveur Abere (2) Inducto (2) Alanta (2) Bahata (2) Bahata (3) Bahata (3) Most (3) Most (3) Abere Most (3	EH4-Fall EH5-Fall EH4-Fall EL6-Found EL6-Found EL6-Found EL6-Found EL6-Found EL6-Found EL6-Found Isamples are interna mean weighted mean 250 95% conf. 25E	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 2.4 22.0 22.0 al errors (2 -30.5 -31.4 20.1 4.4 4.3	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3 ernal error 2.0 1.4 18.5 4.1 3.9	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 -31.4 -24.7 -1.1 -5 (2SD) wf 13.6 15.1 26.6 5.9 5.7	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9 -44.0 10.9 10.9 10.9 20.5 16.1 65.3 14.5	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -1.4 -35.1 44.7 -26.2 -31.8 -23.4 13.0 3.0 2.9	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1 -41.5 10.9 -18.8 -32.3 -23.7 12.5 2.9 2.8	0.1948 0.1956 0.1903 0.1948 0.1909 0.1998 0.1993 0.1896 0.1903 0.1675 0.2285	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Sauveur Abee (2) Inducto (2) Biththeid (2) Worths (3) Moto Biththeid (1) *Uncertainties on individua Carbonaceous Chondrites ALL n = 12	EH4-Fall EH5-Fall EH4-Fall EL6-Found EL6-Found EL6-Found EL6-Found EL6-Found EL6-Found EL6-Found Isamples are interna mean weighted mean 250 95% conf. 25E	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 22.0 al errors (2 -30.5 -31.4 20.1 4.4 4.3 22 -32.4	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3 errnal error 2.0 1.4 18.5 4.1 3.9 22	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 -31.4 -24.7 -1.1 5 (2SD) wf 13.6 15.1 26.6 5.9 5.7 22	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9 -44.0 10.9 10.9 10.9 10.9 10.9 10.9 10.5 16.1 65.3 14.5 13.9	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.5 -1.4 -31.8 -23.4 13.0 3.0 2.9 20 -31.8	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1 -41.5 10.9 -18.8 -32.3 -23.7 12.5 2.9 2.8 20	0.1948 0.1950 0.1903 0.1903 0.1909 0.1909 0.1998 0.1998 0.1998 0.1993 0.1895 0.2285 0.1220 0.2285	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveur Abee (2) Indarch (2) Alartar (2) Alartar (2) Alartar (2) Alartar (2) Michael (2) Ivititi (3) Michael (2) Michael (1) Michael (1) Alartar (2) Alartar	EH4-Fail EH4-Fail EH4-Fail EH4-Fail EL6-Found EL6-Found EL6-Fail EH3-Found EL6-Fail EH3-Found EH3-Found EH4-fail Samples are interna weighted mean yeighted mean yeighted mean weighted mean	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 22.0 al errors (2 -30.5 -31.4 20.1 4.4 4.3 22 -32.4 -33.1	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3 5.7 -17.0 2.2 4.3 2.0 1.4 18.5 4.1 3.9 22 2.2 2.8 4.1	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 -31.4 -24.7 -1.1 5.5 (2SD) w ⁺ 13.6 15.1 26.6 5.9 5.7 22 14.7 15.9	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9 -44.0 10.9 10.9 20.5 16.1 14.5 13.9 22 21.9 16.7	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -1.4 -35.1 44.7 -26.2 -31.8 -23.4 13.0 2.9 20 -31.8 -31.8 -32.3	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1 -41.5 -10.9 -18.8 -32.3 -23.7 12.5 2.9 2.8 20 -32.3 -32.8	0.1948 0.1903 0.1903 0.1909 0.1909 0.1998 0.1998 0.1993 0.1993 0.1993 0.1675 0.2285 0.1920 0.0246 0.0061 18 0.1959	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveur Abee (2) Indarch (2) Alartar (2) Alartar (2) Alartar (2) Alartar (2) Michael (2) Ivititi (3) Michael (2) Michael (1) Michael (1) Alartar (2) Alartar	BH4-Fall BH5-Fall BH4-Fall BH4-Fall BH4-Fall EL6-Found EL6-Found EL6-Found EL6-Fall EL6-Found EL6-Fall BH4-Fall	-13.5 -10.0 -5.5 -16.3 -8.5 -9.6 -10.9 -43.6 2.4 2.4 2.4 2.2 2 -30.5 -31.4 20.1 4.4 4.3 22 -32.4 -32.4 -33.1 3.8	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 4.4 6.8 5.7 -17.0 4.3 erral error 2.0 1.4 18.5 4.1 3.9 22 2.2 4.1 18.5 4.1 18.7 4.1	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 9.9 -31.4 -24.7 -1.1 4 -24.7 -1.1 5.1 26.6 5.9 5.7 22 14.7 15.9 26.9 5.9	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9 -44.0 10.9 10.9 10.9 10.9 20.5 16.1 65.3 14.5 13.9 22 21.9 16.7 68.0 14.5	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -14.5 -14.5 -14.5 -25.1 44.7 -26.2 -31.8 -23.4 13.0 3.0 2.9 20 -31.8 -32.3 13.0 3.0	-13.1 -9.7 1.4 -15.3 -16.0 -16.3 -1.1 -41.5 10.9 -18.8 -32.3 -23.7 12.5 2.9 2.8 20 -32.3 -32.8 20	0.1948 0.1956 0.1993 0.1948 0.1993 0.1948 0.1993 0.1993 0.1993 0.1993 0.2285 0.2285 0.2285 0.0061 18 0.0061 18 0.0959 0.0046 0.0012	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Alexe (2) Indarch (2) Indarc	EH4-Fail EH4-Fail EH4-Fail EH4-Fail EL6-Found EL6-Found EL6-Found EL6-Found EL6-Found EL6-Found EL6-Found Isamples are internal isamples are internal system of the system of the system postic configuration postic config	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 22.0 al errors (2 -30.5 -31.4 20.1 4.4 4.3 22 -32.4 -32.4 -33.1 16.3	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3 ermal error 2.0 1.4 18.5 4.1 3.9 22 2.8 4.1 18.7	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 -31.4 -24.7 -1.1 5 (2SD) wf 15.1 26.6 5.9 5.7 22 14.7 15.9 26.9	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9 -44.0 10.9 10.9 20.5 16.1 65.3 14.5 13.9 22 21.9 16.7 68.0	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -1.4 -35.1 44.7 -26.2 -31.8 -23.4 13.0 3.0 3.0 2.9 20 -31.8 -32.3 13.0	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1 -41.5 10.9 -18.8 -32.3 -23.7 12.5 2.9 2.8 20 -32.3 -32.8 12.5	0.1948 0.1956 0.1903 0.1948 0.1909 0.1993 0.1993 0.1993 0.1993 0.1993 0.1993 0.1993 0.1993 0.1903 0.1903 0.1675 0.2285 0.1920 0.0246 0.0061 18 0.1959 0.0046	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveur Abee (2) Indarch	DH4Fall BH5Fall BH5Fall BH5Fall BH5Fall BH5Fall BH5Fall BH5Fall BH5Fall BH5Fall BH4FAL BH4FAL	-13.5 -10.0 5.5 -16.3 -8.4 -8.5 -9.6 -9.6 -9.6 -9.6 -9.6 -9.6 -9.6 -9.6	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 7.1 4.4 6.8 5.7 -17.0 2.2 4.3 errnal error 14.4 18.5 2.2 2.0 1.4 1.4 1.8,5 2.2 2.2 2.8 4.1 3.9 2.2 2.8 4.1 2.0 2.0 1.4 4.4 2.0 2.0 2.0 1.7 4.4 4.4 2.0 2.0 2.0 2.0 1.7 4.4 4.4 4.4 4.4 4.4 4.4 4.4 4.4 4.4 4	3.4 5.5 0.6 2.0 5.1 5.1 5.1 5.1 5.9 9.9 9.9 9.9 9.9 3.14 2.4.7 5.1 5.5 5.7 5.7 5.7 5.7 22 26.9 5.9 6.0 6.20 9.9 9.9 9.9 9.9 9.9 1.1 5.1 5.1 5.1 5.1 5.1 5.1 5.1 5.1 5.1	0.0 -4.9 -22.4 12.0 15.4 15.5 11.5 -32.9 -10.9 10.9 20.5 16.1 10.9 20.5 16.1 13.9 22 22.9 16.7 68.0 14.5 515.2 20	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -1.4 -35.1 -4.4 -23.4 -26.2 -31.8 -23.4 -20 20 -31.8 -31.8 -22.3 20 20 20	-13.1 9.7 1.4 -15.3 -10.0 -16.3 -10.0 -16.3 -10.0 -18.8 -12.5 2.9 2.8 2.0 -22.3 -32.8 2.0 -32.2 2.9 2.8 2.0 2.0	0.1948 0.1956 0.1903 0.1948 0.1999 0.1993 0.1993 0.1993 0.1993 0.1993 0.1975 0.2285 0.1920 0.0246 0.0061 18 0.1959 0.0046 0.1959 0.0042 0.0011 16	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveuri Abee (2) Indarch	DH4Fall DH5Fall DH5Fall DH4FAll DH4FALL DH4FAL	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 22.0 al errors (2 -30.5 -31.4 20.1 4.4 3.2 -32.4 -33.1 16.3 3.8 3.7	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3 errmal error 2.0 1.4 18.5 4.1 18.5 4.1 18.7 4.1 18.7 4.1 4.2	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 9.9 -31.4 -24.7 1.1 13.6 15.1 26.6 5.9 5.7 22 14.7 15.9 5.9 6.0	0.0 -4.9 22.4 12.0 15.4 22.0 1.5 11.5 -32.9 -44.0 10.5 16.1 65.3 14.5 13.9 22 21.9 16.7 68.0 14.5 15.2	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 -9.4 3.0 -14.5 -0.8 -14.2 -14.5 -14.5 -14.5 -14.5 -14.5 -26.2 -31.8 -22.4 13.0 3.0 2.9 20 -31.8 -32.3 13.0 3.0 3.0 2.9	-13.1 -9.7 1.4 -15.3 -16.3 -10.0 -16.3 -1.1 -41.5 10.9 -18.8 -32.3 -23.7 12.5 2.9 2.8 20 -32.3 -32.8 12.5 2.9 2.8	0.1948 0.1956 0.1903 0.1999 0.1999 0.1993 0.1993 0.1993 0.1993 0.1993 0.1993 0.1993 0.1993 0.1993 0.1993 0.1993 0.1675 0.2285 0.1920 0.0246 0.0001 18 0.1959 0.0046 0.00012 0.00012	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveur Abee (2) Indarch	BH4-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall ELF-Found ELF	-13.5 -10.0 5.5 -16.3 -8.4 -8.5 -10.9 -43.6 -10.9 -43.6 -10.9 -2.4 2.2 -30.5 -31.4 2.2 -31.4 2.3 -31.4 -33.1 16.3 -3.2 -32.4 -32.4 -33.1 -3.5 -3.5 -3.5 -3.5 -3.5 -3.5 -3.5 -3.5	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3 1.4 5.7 -17.0 2.2 4.3 1.4 1.8 5.7 -17.0 2.2 4.3 1.8 5 1.8 5 4.1 1.8 5 2.2 2.0 4.1 1.8 5 5.7 7.0 1.7 7.0 2.2 2.0 1.4 4.4 2.2 2.2 2.2 2.2 2.2 2.2 2.2 2.2 2	3.4 5.5 0.6 2.0 2.1 5.1 5.1 5.1 5.9 5.9 5.7 22 13.6 5.9 5.7 22 26.9 26.9 6.8 6.5 5.9 6.0 20 0 15.2	0.0 -4.9 22.4 12.0 15.4 15.5 15.5 15.5 15.5 15.5 15.5 15.5	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-118 9.4 9.4 9.4 9.4 0.8 -14.5 -14.5 -14.5 -14.5 -14.4 -35.1 24.4 7 -26.2 -31.8 -22.4 13.0 3.0 2.9 20 -31.8 -22.3 13.0 2.9 2.0 	-13.1 9.7 1.4 -15.3 -16.3 -10.0 -16.3 -10.0 -16.3 -1.1 -1.4 -1.5 -1.1 -1.5 -2.2 -2.3 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.8 20 -22.8 20 -22.8 20 -22.8 20 -22.8 20 -22.8 -22.9 -22.8 -22.8 -22.8 -22.8 -22.8 -22.8 -22.8 -22.8 -22.8 -22.8 -22.8 -22.8 -22.8 -22.8 -22.8 -22.8 -22.9 -22.8 -22.9 -22.8	0.1948 0.1956 0.1903 0.1948 0.1999 0.1998 0.1993 0.1993 0.1896 0.1993 0.1225 0.1225 0.1225 0.1225 0.1225 0.0246 0.0246 0.0246 0.0246 0.0012 0.0011 18 0.0046 0.0012 0.0011 16	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveur Abee (2) Indarch	BH4-Fall BH5-Fall BH5-Fall EH6-Found EL6-Found	-135 -163 -160 -5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 -22.0 -30.5 -31.4 -43 -22.0 -31.4 -32.4 -33.1 -33.1 -3.3 -3.5 -33.4 -33.1 -3.5 -3.5 -3.5 -3.5 -3.5 -3.5 -3.5 -3.5	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 -5.7 -7.7 -7.7 -1.7 -1.7 -1.7 -1.7 -1.7 -1	3.4 5.5 0.6 2.0 2.1 5.1 5.1 5.1 5.9 9.9 9.3 1.4 7.4 7.1 1.5 1.5 1.5 1.5 1.5 2.6 5.9 5.7 22 1.4 7.7 2.5 9.9 9.0 1.4 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	0.0 -4.9 -22.4 12.0 15.4 15.4 15.5 11.5 -32.9 -4.40 0.9 10.9 10.9 10.9 20.5 16.1 16.7 68.0 65.3 13.9 22 21.9 16.7 16.7 15.4 13.9 22 21.9 13.7 13.1 15.3 44.5 20 20.9 9.9	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-118 9.4 9.4 9.4 9.4 9.4 0.8 -14.5 -14.5 -14.5 -26.2 -31.8 -22.4 13.0 2.9 20 -31.8 -22.3 3.0 2.9 2.0 -31.8 -22.3 13.0 3.0 2.9 2.0 -14.8 -13.7 -13.7 -13.7 -13.7 -13.7 -14.8 -14.7 -14.8 -14.7 -14.8 -14.8 -14.8 -14.7 -14.8 -1	-111 -97 -14 -153 -163 -163 -163 -163 -11 -145 -163 -163 -163 -163 -217 -223 -223 -223 -223 -223 -228 -229 -28 20 -150 -154 -87 -17 -17	0.1948 0.1956 0.1956 0.1903 0.1948 0.1999 0.1993 0.1993 0.1993 0.1993 0.1993 0.1225 0.1225 0.1225 0.1220 0.0246 0.0246 0.0012 0.0046 0.00120000000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveuri Alexe (2) Indure (1) Indure (1) Indure (2) Indure (2	BH4-Fall BH5	-135 -100 5.5 -16.3 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4 2.4	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 0 1.7 4.4 6.8 5.7 -17.0 2.2 4.3 4.4 1.8 5.7 -17.0 2.2 4.3 4.1 1.8,7 4.1 1.8,7 4.1 2.2 2.0 1.4 1.8,47 2.2 2.0 1.4 4.1 8.9 2.2 2.0 1.4 4.1 8.5 7 7.0 2.2 4.3 4.4 4.4 4.1 8.5 7 7.0 2.2 4.3 4.4 4.4 4.4 4.4 4.4 4.4 4.4 4.4 4.4	3.4 5.5 0.6 0.6 0.6 0.6 0.6 0.5 9.9 9.3 1.4 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	0.0 4.9 22.4 12.0 15.4 22.0 1.5 11.5 11.5 11.5 11.5 11.5 11.5 11.	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-118 9.4 3.0 -14.5 0.8 -14.2 -14.5 -14.5 -14.5 -14.5 -26.2 -26.2 -31.8 -23.4 13.0 3.0 2.9 2.0 	-131 97 14 -153 -163 -163 -163 -163 -111 -155 -188 -223 -223 -228 20 -222 28 20 -1554 -155 -17 17	0.1948 0.1956 0.1956 0.1903 0.1948 0.1998 0.1998 0.1998 0.1995 0.1995 0.1675 0.2255 0.0246 0.0061 18 0.1959 0.0046 0.0012 0.0012 0.0011 16	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveur Aber (2) Indarch	BH4-Fall BH5-Fall BH5-Fall BH5-Fall EL6-Found	-13.5 -10.0 -5.5 -16.3 -8.4 -8.5 -16.9.6 -10.9 -43.6 -2.4 -2.2 -2.2 -30.5 -31.4 -2.2 -31.4 -31.4 -31.4 -32.4 -31.4 -32.4	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -1.7 4.4 4.4 4.5 7 2.2 4.3 2.2 4.3 2.2 2.8 4.1 1.8.5 4.1 1.8.5 2.2 2.2 2.2 2.2 2.2 2.2 2.2 2.2 2.2 2	3.4 5.5 0.6 5.5 0.7 2.0 5.1 5.1 5.1 5.1 5.1 5.1 5.7 5.7 5.7 5.7 5.7 5.7 5.7 5.7 22 14.7 15.9 5.9 5.7 22 0.0 6.0 6.0 6.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2	0.0 -4.9 22.4 12.0 15.4 15.2 20.5 15.7 15.2 20.5 15.2 15.2 15.2 15.2 15.2 15.2 15.2 15.2 15.2 15.2 15.4 1	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 3.0 -14.5 -0.8 -14.5 -14.5 -14.5 -14.5 -14.5 -14.5 -14.5 -14.5 -14.5 -14.5 -14.7 -26.2 -31.8	-131 9.7 1.4 -153 -163 -163 -163 -163 -163 -163 -163 -16	0.1948 0.1956 0.1956 0.1903 0.1948 0.1948 0.1998 0.1993 0.1993 0.1993 0.1993 0.1675 0.1675 0.1675 0.1675 0.1675 0.0246 0.0061 18 0.1959 0.0046 0.0012 0.0011 16 0.1924 0.0022 0.0124 0.0124 0.0124 0.0224 0.0043 0.0044 0.0041 0.0044 0.0041 0.0044 0.0041 0.0044 0.0041 0.0044 0.0041 0.0044 0.0041 0.0044 0.0041 0.0044 0.0041 0.0044 0.0044 0.0041 0.004400000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveuri Abee (2) Indarch	BH4-Fall BH5	-13.5 -16.0 -5.5 -16.3 -8.4 -8.5 -16.9 -43.6 -2.4 -2.0 -2.0 -30.5 -30.5 -31.4 -2.0 -31.4 -33.1 -31.4 -33.1 -32.4 -33.4 -33.3 -32.4 -16.2 -3.5 -16.2 -3.5 -16.3 -3.5 -10.9	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -1.70 4.4 6.8 5.7 -1.70 1.7 4.4 8.5 7 -1.70 1.7 4.4 8.5 7 -1.70 1.7 4.4 8.5 7.7 7.0 1.7 4.4 8.5 7.7 7.0 1.7 4.4 8.5 7.7 7.0 1.7 4.4 8.5 7.7 7.0 1.7 4.4 8.5 7.7 7.0 1.7 4.4 8.5 7.7 7.0 1.7 4.4 8.5 7.7 7.0 1.7 4.4 8.5 7.7 7.0 1.7 4.4 8.5 7.7 7.0 1.7 4.4 8.5 7.7 7.0 1.7 4.4 8.5 7.7 7.0 1.7 4.4 8.5 7.7 7.0 1.4 4.1 8.5 7.7 7.0 1.4 4.1 8.5 7.7 7.0 1.4 4.1 8.5 7.7 7.0 1.4 4.1 8.5 7.7 7.0 1.4 4.1 8.5 7.7 7.0 2.2 2.8 4.1 1.5 2.2 2.9 2.9 2.9 2.9 2.9 2.9 2.9	3.4 5.5 0.6 5.5 0.6 5.1 5.1 5.1 5.1 5.1 5.1 5.1 5.2 5.9 5.7 5.7 5.7 5.7 5.7 5.7 5.7 5.7 5.7 5.7	0.0 -4.9 -22.4 12.0 15.4 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.2 20.5 15.4 20.5 15.5 15.5	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 3.0 -14.5 -0.8 -14.5 -14.5 -14.5 -14.5 -14.5 -14.5 -14.5 -14.5 -14.5 -25.4 -23.4 -23.4 -23.4 -23.4 -23.4 -23.4 -23.4 -23.4 -23.4 -24.5 -20 -20 -20 -20 -20 -20 -20 -20 -20 -20	-111 -9.7 -9.7 -14 -15.3 -10.0 -16.3 -10.0 -16.3 -10.0 -16.3 -10.0 -15.4 -10.0 -15.4 -10.0 -15.4 -15.9 -15.0 -15.9	0.1948 0.1956 0.1956 0.1903 0.1948 0.1908 0.1908 0.1908 0.1903 0.1675 0.1675 0.1675 0.1675 0.1675 0.1675 0.0266 0.0061 18 0.1959 0.0046 0.0011 16 0.1924 0.0044 0.0044 0.0044 0.0044 0.0044 0.0044 0.0044	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveur Aber (2) Indarch	BH4-Fall BH5	-135 -163 -563 -163 -8.4 -8.5 -9.6 -10.9 -43.6 2.4 -31.4 -22.0 -30.5 -31.4 -31.4 -32.0 -31.4 -33.7 -32.4 -33.1 163 3.8 3.7 -166 -2 -2 	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 -1.3 -5.7 -7.7 -7.7 -1.7 -1.7 -1.7 -1.7 -1.7 -1	3.4 5.5 5.5 2.0 -2.1 5.1 5.1 5.1 -0.5 9.9 -3.14 -2.4.7 5.1 5.7 22 2.666 5.9 2.66 5.7 22 2.666 5.7 22 2.666 5.7 22 2.66 5.5 5.7 2.0 -2.1 14.7 15.9 5.9 2.69 2.69 2.69 2.69 2.69 2.69 2.69 2.	0.0 -4.9 -4.9 22.4 15.4 15.4 15.4 15.4 15.5 11.5 -32.9 -44.0 0.9 20.5 16.1 13.9 22 21.9 16.7 68.0 65.3 13.9 22 21.9 16.7 15.4 13.9 22 21.9 13.7 13.1 13.4 13.9 22 21.9 13.5 13.5 13.9 22 21.9 13.5 13.5 13.9 22 21.9 13.5 13.5 13.9 22 21.9 13.5 13.5 13.9 22 21.9 13.5 13.5 13.9 22 21.9 13.5 13.5 13.9 22 21.9 13.5 13.5 13.9 22 21.9 13.5 13.5 13.9 22 21.9 13.5 13.5 13.9 22 21.9 13.5 13.5 13.9 22 21.9 13.7 13.1 13.1 13.9 22 21.9 13.7 13.1	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-118 9.4 3.0 -14.5 -0.8 -14.5 -0.8 -14.5 -14.5 -14.5 -14.5 -14.5 -14.5 -14.5 -23.4 -23.4 -23.4 -23.4 -23.4 -23.1 3.0 2.9 2.0 -20 -20 -21.8 -22.9 -20 -21.8 -22.9 -20 -21.8 -22.9 -20 -20 -20 -20 -20 -20 -20 -20 -20 -20	-111 -111 -97 -143 -163 -163 -163 -163 -163 -163 -163 -16	0.1948 0.1956 0.1956 0.1903 0.1948 0.1948 0.1998 0.1993 0.1993 0.1993 0.1993 0.1675 0.1675 0.1675 0.1675 0.1675 0.0246 0.0061 18 0.1959 0.0046 0.0012 0.0011 16 0.1924 0.0022 0.0124 0.0124 0.0124 0.0224 0.0043 0.0044 0.0041 0.0044 0.0041 0.0044 0.0041 0.0044 0.0041 0.0044 0.0041 0.0044 0.0041 0.0044 0.0041 0.0044 0.0041 0.0044 0.0044 0.0041 0.004400000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveur Aber (2) Indarch	BH4-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH3-Fall BH3-Fall BH3-Fall BH3-Fall Bh3	-135 -100 -55 -16.3 -8.4 -9.6 -10.9 -43.6 -2.4 -10.9 -43.6 -2.4 -10.9 -43.6 -2.4 -10.9 -30.5 -31.4 -2.2 -31.4 -32.4 -32.4 -32.4 -33.1 -33.1 -33.1 -33.2 -33.1 -16.4 -16.2 -2.9 -16.7 -16.7 -16.7 -16.7 -16.7 -16.7 -16.7 -16.7 -16.7 -16.7 -16.7 -16.9 -16.9 -10.9 -16.9 -10.9	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 -1.7 4.1 4.5 4.1 3.9 22 2.0 1.4 1.8 1.9 22 2.8 4.1 3.9 22 2.8 4.1 3.9 22 2.8 4.1 3.9 22 2.8 4.1 3.9 22 2.8 4.1 3.9 22 2.8 4.1 3.9 22 2.8 4.1 3.9 2.2 2.8 4.1 3.9 2.2 2.8 4.1 3.9 2.2 2.8 4.1 3.9 2.2 2.8 4.1 3.9 2.2 2.0 3.6 2.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 2.2 3.2 3	3.4 5.5 0.6 5.5 2.0 -2.1 5.1 5.1 9.9 -3.14 -24.7 (3(250) wh 13.6 15.1 (3(250) wh 13.6 15.1 (3(250) wh 13.6 15.1 (3(250) wh 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0	0.0 4.9 22.4 12.0 15.4 22.0 15.5 -22.9 4.40.0 20.5 16.1 65.3 20.5 16.1 65.3 20.5 16.1 16.5 20.5 16.1 22.0 21.9 16.7 68.0 20.5 16.7 20.5 16.1 16.5 20.5 16.1 20.5 16.1 20.5 16.1 20.5 16.1 20.5 16.1 20.5 20.5 16.1 20.5 20.5 20.5 20.5 20.5 20.5 20.5 20.5	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-118 9.4 3.0 -14.5 -14.5 -14.2 -14.4 -31.8	-111 9-7 14 -153 -163 -163 -100 -100 -101 -111 -125 -125 -125 -125 -125 -229 -228 -229 -228 -229 -228 -229 -228 -229 -228 -229 -228 -229 -228 -229 -228 -229 -228 -229 -228 -229 -229	0.1948 0.1956 0.1956 0.1904 0.1904 0.1904 0.1903 0.1998 0.1998 0.1995 0.1995 0.2285 0.2295 0.2285 0.2295 0.2005 0.	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveuri Abee (2) Indarch	BH4-Fall BH5	-135 -135 -100 -55 -163 -84 -85 -96 -314 -22 -214 -22 -214 -22 -214 -22 -214 -22 -214 -22 -214 -22 -214 -22 -214 -22 -214 -22 -214 -22 -214 -22 -22 -214 -22 -22 -214 -22 -22 -215 -22 -215 -22 -215 -22 -22 -22 -22 -22 -22 -22 -22 -22 -2	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 7.17 4.4 6.8 5.7 7.17 4.4 2.0 1.4 1.8 5.7 7.17 4.4 1.8 5.7 7.17 4.4 1.18 5.7 7.17 4.4 1.13 9.22 2.0 1.4 1.13 2.2 2.0 1.4 1.13 2.2 2.0 2.8 4.1 1.5 2.9 2.9 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 5.1 -0.5 5.1 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5	0.0 4.9 22.4 12.0 15.4 22.0 15.5 22.0 10.9 10.9 10.9 10.9 22.0 10.9 10.9 22.0 10.9 10.9 22.0 10.9 10.9 22.0 10.9 20.5 10.5 20.9 21.9 10.7 13.1 13.1 13.1 13.2 20.0 13.7 13.1 13.1 13.1 13.1 13.1 13.1 13.1	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-118 9.4 9.4 3.0 -14.5 -14.2 -14.5 -14.2 -14.4 -25.1 -14.4 -25.4 -22.4 -14.7 -26.2 -20 -20 -20 -20 -20 -20 -20 -20 -20 -2	-131 9-7 14 -153 -163 -160 -160 -160 -160 -188 -227 125 28 -227 228 -228 -228 -228 -228 -228 -2	0.1948 0.1956 0.1903 0.1993 0.1993 0.1993 0.1993 0.1993 0.1993 0.1993 0.2255 0.2255 0.2255 0.2255 0.2265 0.2275 0.0002 0.00000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Aser (2) Martine	BH4-Fall BH5	-135 -135 -100 -55 -163 -84 -85 -96 -436 -85 -96 -436 -24 -220 -305 -314 -43 -22 -305 -314 -43 -22 -324 -43 -32 -4 -33 -43 -32 -4 -32 -4 -32 -4 -32 -4 -32 -4 -32 -4 -32 -4 -32 -4 -32 -4 -32 -4 -32 -4 -32 -4 -32 -32 -4 -32 -4 -32 -32 -4 -32 -32 -4 -32 -32 -4 -32 -32 -4 -32 -32 -4 -32 -32 -32 -32 -32 -32 -32 -32 -32 -32	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 7.1 7.0 2.2 2.0 1.4 4.1 1.8 5 7 2.2 2.0 1.4 4.1 1.8 5 7 2.2 2.0 1.4 4.1 1.8 5 7 7 2.2 2.0 1.4 4.3 9 22 20 2.0 2.0 1.4 1.8 5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	3.4 5.5 0.6 2.0 -2.1 5.1 -0.5 5.1 -0.5 5.1 -0.5 1.5 1.5 1.5 1.5 2.4.7 -1.1 1.5 1.5 1.5 2.4.7 -2.5.7 -2.4.7 -2.2.7 -2.7 -	0.0 -4.9 -4.9 22.4 12.0 15.4 -4.9 12.0 15.4 -4.9 12.0 15.4 -4.9 12.0 15.4 -4.9 12.0 15.4 -2.9 10.0 10.0 1	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 3.0 -14.5 -0.8 -14.2 -14.5 -14.2 -14.4 -14.4 -35.1 -14.4 -7 -26.2 -31.8 -22.4 -31.8 -22.4 -31.8 -22.4 -31.8 -22.4 -20 -31.8 -20 -31.8 -20 -31.8 -20 -20 -31.8 -20 -20 -31.8 -20 -20 -31.8 -20 -20 -20 -20 -20 -20 -20 -20 -20 -20	-13.1 9.7 14 -15.3 -16.3 -10.0 -16.3 -10.0 -16.0 -18.8 -22.3 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.9 -22.8 20 -22.3 -22.8 20 -22.3 -22.9 -2	0.1948 0.1956 0.1956 0.1904 0.1904 0.1904 0.1903 0.1998 0.1998 0.1995 0.1995 0.2285 0.2295 0.2285 0.2295 0.2005 0.	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Asee (2) Indent (2)	BH4-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH2-Found LE4-Found LE4-Found LE4-Found LE4-Found Bangles are interval Bangles are interval Bangles are interval poly Scott and Scott a	-135 -135 -100 -55 -163 -84 -85 -96 -169 -436 -24 -20 -314 -420 -305 -314 -43 -31 -32 -324 -331 -32 -324 -33 -32 -324 -33 -32 -32 -4 -33 -32 -32 -32 -32 -32 -32 -32 -32 -32	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 -5.0 -7.7 -7.0 -7.7 -7.0 -7.7 -7.0 -7.7 -7.0 -7.7 -7.0 -7.7 -7.0 -7.7 -7.0 -7.7 -7.0 -7.7 -7.0 -7.7 -7.7	3.4 5.5 0.6 5.5 0.0 -2.1 5.1 -0.5 9.9 -31.4 9.9 -31.4 13.6 15.1 5.7 -24.7 -1.1 13.6 15.1 5.9 0.2 26.5 5.7 22 25.6 6.0 6.0 6.5 5.7 22 2.0 20 -2.1 -2.4 7 15.9 9.9 -3.1 -2.4 7 -2.5 9 9 -3 -2.4 7 -2.4 -2.4 -2.4 -2.5 -2.4 -2.5 -2.4 -2.5 -2.4 -2.5 -2.4 -2.5 -2.5 -2.5 -2.5 -2.5 -2.5 -2.5 -2.5	0.0 -4.9 -2.4 -4.9 -2.4 -5.4 -2.0 -3.2 -	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-118 9.4 9.4 3.0 -14.5 -0.8 -14.2 -14.5 -14.2 -14.2 -14.2 -14.4 -35.1 -14.4 -31.8 -23.4 -23.4 -23.4 -23.4 -22.4 -20 -20 -20 -20 -20 -20 -20 -20 -20 -20	-13.1 9.7 14 -15.3 -16.3 -10.0 -16.3 -10.0 -18.8 -10.0 -18.8 -23.7 -23.7 -22.8 20 -22.3 -22.8 20 -22.3 -22.8 20 -22.3 -22.2 22 22 22 22 22 22 22 22 22 22 22 22	0.1956 0.1956 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Asee (2) Indent (2)	BH4-Fall BH5	-135 5 -100 -55 - -100 -55 - -163 -84 - -96 - -109 -436 - -22 - -2	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 5.0 7.7 7.0 7.7 7.0 1.7 4.4 5.7 5.7 5.7 7.0 2.2 4.3 7.7 7.0 1.7 4.4 5.7 7.7 7.0 1.7 4.4 5.7 7.7 7.0 1.7 4.4 4.1 1.85 1.85 2.2 2.2 2.2 2.2 2.2 2.2 2.2 2.2 2.2 2.	3.4 5.5 0.6 5.5 0.6 2.0 -2.1 5.1 -0.5 9.9 9.9 -3.14 2.42,7 -1.1 13.6 5.9 9.9 2.42,7 -1.1 (155) w ² 2.42,7 -1.1 (155) w ² 2.6 5.7 2.2 2.0 2.0 6.0 6.8 6.5 6.5 6.2 6.2 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2	0.0 0.0 -4.9 22.4 12.0 15.4 22.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 10.9 22.0 11.5 12.0 10.5 11.5 12.0 10.5 11.5 12.0 10.5 11.5 12.0 10.5 11.5 12.0 10.5 11.5 12.0 10.5 10	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-118 9-4 9-4 30 -14-5 -14-2 -14-5 -14-2 -14-4 -14-4 -14-4 -22-4 -14-7 -22-2 -22-4 -22-2 -22-4 -22-2-2 -2-2-2 -2-2-2 -2-2-2 -2-2-2 -2-2-2-2 -2-2-2-2 -2-2-2-2 -2-2-2-2 -2-2-2-2 -2-2-2-2-2 -2-2-2-2 -2-2-2-2-2-2 -2	-131 9-7 14 -153 -163 -160 -163 -100 -163 -100 -141 -415 -100 -141 -122 -223 -223 -223 -223 -223 -223 -22	0.1956 0.1956 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.0056 0.0051 0.0051 0.0051 0.0051 0.0055	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Aser (2) Markan (2)	BH4-Fall BH5	-135 -135 -100 -5.5 -16.3 -8.4 -9.6 -10.9 -43.6 -2.4 -2.0 -43.6 -2.4 -2.0 -43.6 -2.4 -	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 5.0 7.7 7.0 1.7 4.4 6.8 5.7 7.1 7 4.4 6.8 5.7 7.2 2 2.0 1.4 4.1 8.5 7 1.7 1.8 5 4.1 1.8 5 7 2.2 2.0 1.4 3.9 2.2 2.0 1.4 4.3 1.8 5 7 7 7 7 0 7 7 7 7 0 7 7 7 7 7 7 7 7 7	3.4 5.5 0.6 5.5 0.6 5.7 0.7 0.5 1.5 1.7 0.5 9.9 -3.14 0.5 9.9 -3.14 0.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1	0.0 0.0 -4.9 22.4 12.0 15.4 -4.9 22.0 15.4 -8.29 22.0 15.4 -8.29 22.0 15.4 -8.29 22.0 15.4 -8.29 22.0 15.4 8.0 9.3 22.0 15.5 13.9 22.0 15.5 13.9 22.0 15.5 13.9 22.0 15.5 13.9 22.0 15.5 13.9 22.0 15.5 16.1 16.1 16.1 16.1 16.7 17.7	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 9.4 3.0 -14.5 -0.8 -14.2 -14.5 -14.2 -14.4 -14.4 -26.2 -22.4 -14.8 -22.4 -	-131 9-7 14 -153 -163 -160 -163 -100 -183 -100 -183 -100 -183 -100 -183 -223 -223 -223 -223 -223 -223 -223 -2	0.1958 0.1956 0.1956 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 1.0155 0.0005 00	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Abee (2) Indarch	BH4-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH6	-135 3 -135 3 -100 -5.5 -30.5 -316 3 -36 -31.4 -32 -33.4 -33.1 -32.4 -33.1 -32.4 -33.1 -32.4 -33.1 -32.4 -33.1 -32.4 -33.1 -3.5 -3.5 -3.5 -3.5 -3.5 -3.5 -3.5 -3.5	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.0 7.7 7.0 7.7 7.0 7.7 7.0 7.7 1.7 4.4 4.4 4.4 4.4 4.4 4.4 4.5 7.7 7.1 7.0 2.2 4.3 9.2 2.0 1.4 4.1 4.4 4.4 4.4 4.4 4.1 3.9 2.2 2.8 4.1 4.1 4.2 2.0 1.4 4.1 4.4 4.4 4.4 4.4 4.4 4.4	3.4 5.5 0.6 5.5 0.0 -2.1 5.1 5.1 0.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1	0.0 0.0 -4.9 22.4 1.5 1.2 1.2 1.2 1.2 1.2 1.2 1.2 1.2	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 9.4 3.0 -34.5 -34.2 -44.2 -44.2 -44.3 -44.2 -44.3 -44.7 -26.2 -31.8 -32.8 -31.8 -32.9 -32.8 -32.8 -32.8 -32.9 -32.8 -32.9 -32.8	-131 9-7 14 -9-7 -15-3 -16-3 -1000 -100 -1000 -1	0.1958 0.1956 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.0055 0.0055 0.0055 0.0052 0.0052 0.0052 0.00550 0.00550 0.005500000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Aser (2) Markan (2)	BH4-Fall BH5	-135 3 -160 -55 -160 -55 -163 -46 -46 -54 -40 -54 -40 -40 -40 -24 -40 -40 -24 -40 -40 -20 -160 -20 -31 -40 -40 -31 -40 -40 -32 -40 -40 -40 -40 -40 -40 -40 -40 -40 -40 -40 -40 -40 -40 -40 -40	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 5.0 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7	3.4 5.5 0.6 2.0 4.21 3.12 3.12 3.12 3.12 3.12 3.12 3.12 3	0.0 4.9 4.9 22.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 12.2 12.2 12.2 12.0 12.2 12.	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 9.4 3.0 -14.5 -14.2	-131 9-7 14 9-7 153 -153 -163 -163 -160 -151 109 -223 -223 -225 29 28 20 -160 -154 8 7 29 28 20 -160 -154 8 7 29 28 20 -160 -153 -23 29 28 20 -160 -153 -23 29 28 20 -160 -153 -23 29 28 20 -160 -153 -23 20 -163 -23 20 -163 -23 20 -163 -23 20 -23 -23 -23 -23 -23 -23 -23 -23 -23 -23	0.1949 0.1956 0.1956 0.1950 0.1950 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.0266 0.0056 18 0.0056 18 0.0056 0.0051 20 0.0056 0.0051 20 0.0054 0.0054 0.0054 0.005500000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Asee (2) Indum (2) Ind	BH4-Fall BH5	-1355 -160 -55 -160 -55 -163 -84 -84 -84 -84 -84 -84 -84 -84 -84 -24 -163 -24 -164 -220 -201 -201 -201 -201 -201 -201 -201	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 5.0 7.7 7.7 7.7 7.7 7.7 7.7 7.7 4.4 4.4	3.4 5.5 0.6 2.0 4.21 5.5 5.0 4.2 5.2 9.2 3.14 4.24.7 3.1252 3.1252 3.1252 3.1252 3.1252 3.1252 3.152 3.28 2.29 7.1 6.6 6.5 5.9 6.0 6.8 6.5 5.9 6.0 7.1 6.6 6.5 2.0 7.1 6.6 6.5 2.0 7.1 6.6 6.5 2.0 7.1 6.6 6.5 2.0 7.1 7.1 7.1 7.1 7.1 7.1 7.1 7.1 7.1 7.1	0.0 4.9 4.9 22.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 12.2 12.0 12.2 12.	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 9.4 3.0 -14.5 -14.5 -14.2	-13.1 9.7 1.4 9.7 1.5.3 -15.3 -16.3 -16.3 -16.0 9.2 2.9 2.8 2.0 -16.0 -10.9 2.8 2.0 2.8 2.0 2.8 2.0 -16.0 -15.4 8.7 1.7 1.7 2.8 -10.5 2.9 2.8 2.0 -16.0 -15.3 2.9 2.8 2.0 -16.0 -15.3 2.9 2.8 2.0 -16.0 -15.3 2.9 2.8 2.0 -16.0 -15.3 2.9 2.8 2.0 2.0 -15.3 2.9 2.8 2.0 2.0 -15.3 2.9 2.8 2.0 2.0 -15.3 2.9 2.8 2.0 2.0 -15.3 2.9 2.8 2.0 2.0 -15.3 2.9 2.8 2.0 2.0 -15.3 2.9 2.8 2.0 2.0 -15.3 2.9 2.8 2.0 2.0 -15.3 2.9 2.8 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 -15.4 2.0 2.0 -15.4 2.0 2.0 -15.4 2.0 -1	0.1954 0.1956 0.1956 0.1950 0.1950 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.0266 0.0266 0.0056 16 0.0051 0.0054 0.0056 0.0054 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0057 0.0056 0.0056 0.0056 0.0057 0.0056 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057 0.0056 0.0057000000000000000000000000000000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Asee (2) Indum (2) Ind	BH4-Fall BH5	-1155 -100 -55 -100 -55 -100 -55 -100 -55 -100 -100	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 5.0 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7	3.4 5.5 0.6 2.0 -2.1 3.5 0.6 3.5 0.6 3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5	0.0 4.9 4.9 22.4 1.5 1.5 1.5 1.5 1.5 1.5 2.2 2.5 1.5 1.5 2.5 1.5 2.5 2.5 2.5 1.5 2.5 1.5 2.5 1.5 2.5 1.5 1.5 2.5 1.5 1.5 2.5 1.5 1.5 2.5 1.5 1.5 2.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 9.4 3.0 -14.5	-13.1 9.7 14 -9.7 -15.3 -16.3 -16.3 -16.3 -16.0 -17.7	0.1956 0.1956 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.0006 0.0006 0.0001 0.0001 0.0001 0.0005005 0.000500000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Aser () Martania Bartenia () Barthenia () Barthenia () Barthenia () Mort 17 Vaces and Sainthenia () Carbonascess Chondrites AL n = 12 Carbonascess Chondrites AL n = 10 Carbonascess Chondrites AL n = 25 Carbonascess Chondrites Carbonascess Chona	BH4-Fall BH5	-1355 -160 -55 -160 -55 -163 -84 -84 -84 -84 -84 -84 -84 -84 -84 -24 -163 -24 -164 -220 -201 -201 -201 -201 -201 -201 -201	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 5.0 7.7 7.7 7.7 7.7 7.7 7.7 7.7 4.4 4.4	3.4 5.5 0.6 2.0 4.21 5.5 5.0 4.2 5.2 9.2 3.14 4.24.7 3.1252 3.1252 3.1252 3.1252 3.1252 3.1252 3.152 3.28 2.29 7.1 6.6 6.5 5.9 6.0 6.8 6.5 5.9 6.0 7.1 6.6 6.5 2.0 7.1 6.6 6.5 2.0 7.1 6.6 6.5 2.0 7.1 6.6 6.5 2.0 7.1 7.1 7.1 7.1 7.1 7.1 7.1 7.1 7.1 7.1	0.0 4.9 4.9 22.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 15.4 12.0 12.2 12.0 12.2 12.	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 9.4 3.0 -14.5 -14.5 -14.2	-13.1 9.7 1.4 9.7 1.5.3 -15.3 -16.3 -16.3 -16.0 9.2 2.9 2.8 2.0 -16.0 -10.9 2.8 2.9 2.8 2.0 -2.2 3.1 2.9 2.8 2.0 -1.5 4.5 2.9 2.8 2.0 -2.2 2.9 2.8 2.0 -1.5 2.9 2.8 2.0 -1.5 2.9 2.8 2.0 -1.5 2.9 2.8 2.0 -1.5 2.9 2.8 2.0 -1.5 2.9 2.8 2.0 2.0 -1.5 2.9 2.8 2.0 2.0 -1.5 2.9 2.8 2.0 2.0 -1.5 2.9 2.8 2.0 2.0 -1.5 2.9 2.8 2.0 2.0 -1.5 2.9 2.8 2.0 2.0 -1.5 2.9 2.8 2.0 2.0 -1.5 2.9 2.8 2.0 2.0 -1.5 2.9 2.8 2.0 2.0 -1.5 2.9 2.8 2.0 2.0 -1.5 2.9 2.8 2.0 2.0 -1.5 2.9 2.8 2.0 2.0 -1.5 2.9 2.8 2.0 2.9 2.8 2.0 2.9 2.8 2.0 2.9 2.8 2.0 2.9 2.8 2.0 2.0 2.9 2.8 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0	0.1954 0.1956 0.1956 0.1950 0.1950 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.0266 0.0266 0.0056 16 0.0051 0.0054 0.0056 0.0054 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056 0.0057 0.0056 0.0056 0.0056 0.0057 0.0056 0.0056 0.0057000000000000000000000000000000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Asee (2) Indum (2) Ind	BH4-Fall BH5	-1155 -100 -55 -100 -55 -100 -55 -100 -48 -48 -48 -48 -48 -24 -22 -314 -43 -22 -314 -43 -22 -314 -44 -32 -32 -314 -43 -32 -32 -314 -43 -32 -32 -314 -33 -32 -32 -32 -31 -33 -32 -32 -32 -31 -33 -32 -32 -32 -32 -32 -32 -32 -32 -32	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 5.0 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7	3.4 5.5 0.6 5.5 0.6 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	0.0 4.9 4.9 224 1120	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 9.4 9.4 14.5 9.4 14.5 9.4 14.5 14.5 14.5 14.5 14.5 14.5 14.5 14	-131 9-7 14 -9-7 14 -153 -163 -163 -163 -163 -163 -163 -163 -16	0.1958 0.1956 0.1956 0.1950 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.0266 0.0056 10 0.0266 0.0056 0.0056 0.0056 0.0056 0.0056 0.0056	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Aser () Martania Bartenia () Barthenia () Barthenia () Barthenia () Mort 17 Vaces and Sainthenia () Carbonascess Chondrites AL n = 12 Carbonascess Chondrites AL n = 10 Carbonascess Chondrites AL n = 25 Carbonascess Chondrites Carbonascess Chona	BH4-Fall BH5	-1155 -100 -55 -100 -55 -100 -48 -48 -48 -48 -48 -48 -24 -22 -220 -220 -220 -220 -220 -220 -	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 5.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7	3.4 5.5 0.6 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	0.0 4.9 4.9 22.4 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 9.4 3.0 4.45 4.45 4.45 4.45 4.45 4.45 4.45 4.	-131 9-7 14 -153 -163 -163 -163 -163 -163 -164 -164 -164 -188 -227 -227 -228 -228 -228 -228 -228 -2	0.1958 0.1956 0.1956 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.0005 10000000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Aser () Martania Bartenia () Barthenia () Barthenia () Barthenia () Mort 17 Vaces and Sainthenia () Carbonascess Chondrites AL n = 12 Carbonascess Chondrites AL n = 10 Carbonascess Chondrites AL n = 25 Carbonascess Chondrites Carbonascess Chona	BH4-Fall BH5	-1155 -1150 -1000 -55 -1000 -55 -1000 -424 -424 -424 -424 -424 -424 -424 -	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 -1.3 -5.0 -1.7 -7.7 -2.2 -2.3 -2.5 -2.3 -2.3 -2.3 -2.3 -2.3 -2.3 -2.3 -2.3 -2.3 -2.5	3.4 5.5 0.6 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	0.0 4.9 4.9 2124 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 9.4 9.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1	-111 9-7 9-7 9-7 9-7 14 14 14 14 14 14 14 14 14 14 14 14 14	0.1956 0.1956 0.1950 0.1950 0.1950 0.1950 0.1950 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.0056 0.0051 0.0055 0.0051 0.0055 0.0055	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Aser () Martin Martin () Martin Martin () Martin Ma	BH4-Fall BH5	-1155 -1150 -55 -1000 -55 -1000 -414 -44 -44 -43 -205 -109 -415 -415 -415 -415 -415 -415 -415 -415	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 -1.3 -5.7 -1.7 -7.7	3.4 5.5 0.6 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	0.0 4.9 4.9 224 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 9.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1	-111 9-7 14 143 -163 -163 -163 -163 -163 -163 -163 -16	0.1958 0.1556 0.1556 0.1550 0.1550 0.1550 0.1550 0.1550 0.1550 0.1550 0.1550 0.1550 0.1550 0.1557 0.1555 0.1555 0.1555 0.0566 0.0006 0.0006 0.0006 0.000400000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saveur Abee (2) Indarch	BH4-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH5-Fall BH2-Found LE4-Found LE4-Found LE4-Found LE4-Found LE4-Found LE4-Found De15-Beneration 250 95% cont mean weighted mean 3250 3250 n weighted mean 3250 3250 n weighted mean 3250 3250 n mean mean mean mean mean mean mean me	-1155 -1250 -1000 -555 -1009 -55 -4164 -417 -4164 -416	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -1.3 -1.3 5.0 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7	3.4 5.5 0.6 0.5 0.6 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	0.0 4.9 4.9 224 4.9 224 4.9 225 115 115 125 125 125 125 125	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-11.8 9.4 9.4 9.4 14.2 14.5 14.5 14.5 14.5 14.5 14.5 14.5 14.5	-111 9-7 14 1-5 1-5 1-5 1-5 1-5 1-5 1-5 1-5 2-5 2-5 2-5 2-5 2-5 2-5 2-5 2-5 2-5 2	0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.0266 0.0266 0.0266 0.0265 0.0051 0.0051 0.0051 0.0054 0.005500000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Aser () Martin Martin () Martin Martin () Martin Ma	BH4-Fall BH5	-1355 -1365 -1000	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 -1.3 -1.3 -1.3 -1.3 -1.7 -7.0 -7.7 -7.7 -7.7 -7.7 -7.7 -7.7 -7	3.4 5.5 0.6 0.5 0.6 0.5 0.6 0.5 0.6 0.5 0.0 0.0 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	0.0 4.9 4.9 212 4.9 212 4.9 212 212 212 212 212 20 205 115 115 205 205 115 205 205 205 205 205 205 205 20	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-118 9.4 9.4 9.4 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	-111 9-7 9-7 9-7 9-7 14 14 1-4 1-4 1-4 1-4 1-4 1-4 1-4 1-4 1	0.1956 0.1956 0.1956 0.1950 0.1950 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.0005 1.1959 0.0005 1.1959 0.0005 1.0005 1.0005 0.0005 1.	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Asee (2) Indern (2)	BH4-Fall BH5	-1155 -1255 -1000 -500 -500 -500 -1009 -404 -404 -404 -404 -404 -404 -404 -	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 -1.3 -1.3 -1.7 -7.0 -7.7 -7.7 -7.7 -7.7 -7.7 -7.7 -7	3.4 5.5 0.6 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	0.0 4.9 4.9 2124 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-118 9.4 9.4 9.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1	-111 9-7 9-7 9-7 4-8-3 1-4-3 -16-16-3 -16-	0.1954 0.1956 0.1956 0.1950 0.1950 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.0266 0.0266 0.005500000000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Asee (2) Indern (2)	BH4-Fall BH5	-135 5 -136 5 -100 5 -1	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 -1.3 -1.3 -1.3 -1.3 -1.7 -7.0 -7.7 -7.7 -7.7 -7.7 -7.7 -7.7 -7	3.4 5.5 5.5 0.6 0.6 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	0.0 0.0 4.9 4.9 2.12 1.4 2.12	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-118 9.4 9.4 9.4 9.4 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	-111 -17 -17 -163 -160 -163 -17 -17 -17 -17 -17 -17 -17 -17	0.1956 0.1956 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.1950 0.0056 0.0056 0.0001 10 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0005 0.0000	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011
Saint-Saneuri Asee (2) Indern (2)	BH4-Fall BH5	-1155 -1250 -1000 -500 -500 -500 -1000 -500 -100	1006.2 1023.7 745.3 981.2 1334.5 1075.3 1284.6 640.0 950.5 689.4 2651.4	-3.3 -3.3 -1.3 -1.3 -1.3 -1.3 -1.3 -1.3	3.4 5.5 6.6 7.1 7.1 7.1 7.1 7.1 7.1 7.1 7.1 7.1 7.1	0.0 0.0 4.9 4.9 212 4.9 212 4.9 212 212 212 212 213 205 113 113 113 1	3.4 3.2 4.5 20.8 4.8 9.7 9.9 5.7 17.1 4.4	2.5 3.1 6.6 8.6 0.0 0.6 4.9 15.3 4.1 1.9	3.2 4.0 12.2 4.5 0.0 4.1 17.4 2.9 7.7	5.0 6.6 10.0 6.4 2.3 0.6 7.4 28.4 21.5 10.5	8.5 9.7 3.0 9.0 14.4 15.0 11.5 32.7 40.9	-118 9.4 9.4 9.4 9.4 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	-111 9,7 9,7 9,7 4,63 4,63 4,63 4,63 4,63 4,63 4,63 4,63	0.1949 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.1959 0.2056 0.0056 0.0056 0.0056 0.0051 0.0056 0.0051 0.0056 0.0051 0.0056 0.0051 0.0056 0.0051 0.0056 0.0051 0.0056 0.0055 0.0056 0.	Burkhardt et al., 2016 Burkhardt et al., 2016 This study Boyet and Carlson 2005 Gannoun et al., PNAS 2011

Table S2. Nd compositions of MS-177 and terrestrial samples

	Nd	I145	¹⁴² Nd/ ¹⁴⁴ Nd	2SE	¹⁴³ Nd/ ¹⁴⁴ Nd	2SE	¹⁴⁵ Nd/ ¹⁴⁴ Nd	2SE	¹⁴⁸ Nd/ ¹⁴⁴ Nd	2SE	¹⁵⁰ Nd/ ¹⁴⁴ Nd	2SE	¹⁴² Ce/ ¹⁴² Nd	¹⁴⁴ Sm/ ¹⁴⁴ Nd	N
	(ng)	(V)											(ppm)	(ppm)	
JNdi-1_F1R1	500	0.97	1.141852	0.000006	0.512110	0.000002	0.348403	0.000001	0.241576	0.000002	0.236445	0.000002	0.7	0.4	540
JNdi-1_F1R2	500	0.97	1.141850	0.000005	0.512112	0.000002	0.348403	0.000001	0.241578	0.000001	0.236445	0.000002	0.2	0.3	900
JNdi-1_F2R1	500	1.28	1.141847	0.000004	0.512110	0.000001	0.348403	0.000001	0.241579	0.000001	0.236446	0.000001	0.3	0.4	900
JNdi-1_F3R1	500	1.68	1.141853	0.000003	0.512111	0.000001	0.348403	0.000001	0.241579	0.000001	0.236448	0.000001	0.3	0.5	900
JNdi-1_F4R1	250	0.70	1.141844	0.000006	0.512108	0.000002	0.348402	0.000001	0.241579	0.000002	0.236448	0.000002	0.4	0.3	900
JNdi-1_F5R1	250	1.48	1.141851	0.000004	0.512114	0.000002	0.348404	0.000001	0.241579	0.000001	0.236448	0.000002	0.3	0.5	720
JNdi-1_F6R1	250	0.97	1.141852	0.000004	0.512112	0.000002	0.348403	0.000001	0.241579	0.000001	0.236446	0.000002	0.34	0.42	900
Mean JNdi-1			1.141850		0.512111		0.348403		0.241578		0.236446		0.4	0.4	
2s			0.000006		0.000004		0.000002		0.000002		0.000003				
2s (ppm)			5.6		7.4		4.4		8.2		10.9				
n			7		7		7		7		7				
MS177_F9R1	300	0.64	1.141838	0.000007	0.512439	0.000002	0.348405	0.000001	0.241581	0.000002	0.236448	0.000002	1.2	0.3	640