OXYGEN ISOTOPES IN CHONDRITIC INTERPLANETARY DUST : PARENT-BODIES AND NEBULAR OXYGEN RESERVOIRS. J. Aléon[1] , K. D. McKeegan[2] and L. Leshin[3]. [1]LLNL, Glenn T. Seaborg Institute, Livermore CA 94550, aleon2@llnl.gov . [2]UCLA, Earth and Space Sciences, Los Angeles CA 90095-1567, [3]NASA Goddard Space Flight Center, Greenbelt MD 20771.

Introduction: Planetary objects have preserved various amounts of oxygen derived from isotopically distinct reservoirs reflecting their origins and diverse physico-chemical histories [1]. An ^{16}O-rich component is preserved in high temperature phases, such as refractory inclusions (CAIs) and some chondrules, whereas meteorite matrices are enriched in a relatively ^{16}O-poor component [2]. The origin of these components is still unclear. The most recent models postulate that isotope selective photodissociation of CO in a ^{16}O-rich nebula/presolar cloud resulted in a ^{16}O-poor (i.e., ^{17}O- and ^{18}O-enriched) reactive gas in regions of the solar nebula or parent molecular cloud where self-shielding effects occur [3-5]. The resulting ^{16}O-poor reservoir can be sequestered in water ice which will not equilibrate isotopically with dust in cold regions of the nebula. Most oxygen isotope heterogeneity is documented meteorites which are thought to have formed in the inner 3AU of the solar nebula, and the precise isotopic composition of outer solar system components is as yet unknown. Thus, the oxygen isotopic composition of cometary dust is a key to understanding the origin of oxygen isotopic heterogeneity in the solar system.

The Stardust mission will bring back to the Earth dust samples from comet Wild2, a short period comet from the Jupiter family. A high priority is a precise determination of the oxygen isotope compositions of Wild2 dust grains, however the Stardust samples may be extremely fragmented upon impact in the collector making such analyses difficult. Interplanetary dust particles (IDPs) collected in the stratosphere are likely to contain comet samples. Therefore, we started to investigate the oxygen isotopic composition of a suite of chondritic interplanetary dust particles that include IDPs of potential cometary origin using a refined procedure to increase the lateral resolution down to ~ 3 µm. High precision data for 4 IDPs were previously reported by [6], here we have measured 5 additional IDPs.

Analytical techniques: Oxygen isotopes were measured with the CAMECA IMS 1270 at UCLA in two different modes. IDPs were pressed into high purity gold foils and all measurements were done using the electron flood gun for charge compensation and high mass resolving power (> 5000) to avoid contribution of the OH peak at mass 17. A liquid N_2 trap was used to limit vacuum contamination. Data were corrected for detector background and deadtime. In the absence of OH tail and linear drift correction, the results presented here should be considered preliminary.

High precision analyses (HP) were performed using a 20-30 µm Cs+ beam of 0.3 nA. ^{16}O, ^{17}O and ^{18}O were acquired in 30 cycles of 2, 10, 10 s, respectively on a Faraday Cup (^{16}O) and an electron multiplier (EM, ^{17}O and ^{18}O). Pressure in the chamber was below 5×10^{-9} Torr. Standards were polished sections of a San Carlos olivine and a Burma spinel. In this mode, we obtained bulk O isotopic composition for most particles except L2036 R5, a big IDP, for which 3 analyses were taken. In these conditions, the overall precision of individual measurements is about 2 ‰ (2 σ).

High lateral resolution analyses (HR) were performed using a 2-3 µm Cs+ beam of 5 pA. All isotopes were measured on the EM. Because of a higher susceptibility to vacuum contamination, all analyses were done with a pressure below 2×10^{-9} Torr. Standards were crushed grains of a San Carlos olivine mounted on Au. A first bulk analysis of the particle was obtained using a raster adjusted to the particle. ^{16}O-images on the EM were used to locate subcomponents larger than 3 µm and the raster was adjusted to analyze these components. The typical precision was better than 6 ‰ for δ^{18}O and 10‰ for δ^{17}O (2 σ).

Samples: All IDPs were mapped by Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Spectroscopy before analysis to have an estimate of their morphology and mineralogy. H and N isotopes were available for some of the particles [7,8].

L2036 R5: Smooth, non-cluster, 70 µm IDP. The H content suggests the particle is hydrated. It contains Fe-rich framboids, probably magnetite (mt).

L2021 A6: Fluffy porous cluster IDP < 8 µm, with δD up to 1900 ‰. The residue from previous D/H analyses was sputtered away during measurement resulting in a significant amount of contamination.

L2036 B3: Cluster IDP ~10 µm with smooth texture and Fe-rich framboids, probably mt. A 5 µm mt-rich region was analyzed individually by HR analysis.

L2021 N3: Cluster IDP ~11 µm, fluffy with Fe-rich and Ca-Al-rich grains. It contains a 5 µm, very Mg-rich crystal (probably forsteritic olivine) that was analyzed individually by HR analysis.

L2036 W1: Extremely fine-grained cluster IDP ~10 µm with homogeneous chondritic composition. Grain-size is < 100 nm, determined from SEM images.

Particles R5 and B3 are probably hydrated IDPs of possible asteroidal origin, whereas A6, N3 and especially W1 are probably chondritic porous anhydrous IDPs of possible cometary origin.

Results and discussion: All IDPs have bulk compositions comparable to chondritic components, close to the terrestrial fractionation (TF) line.

Hydrated IDPs (R5, B3 and U222C6 [6]) have the typical composition of hydrated chondrite matrices, suggesting that such IDPs are indeed from similar parent bodies. Notably, B3 has a very heavy composition similar to metamorphosed CI chondrites [9]. Anhydrous IDPs, on the other hand seem to align closely to the slope 1.00 line observed in some CAIs [e.g. 10], both above and below the TF line. Coarse-grained olivine (N3) and pyroxene [6] are similar to the bulk particles. Interestingly, W1 shows a slight ^{16}O depletion comparable with magnetite from unequilibrated ordinary chondrites [11]. Its fine-grained nature suggests that it may contain glass with embedded metal and sulfides (GEMS), but this has not yet been determined by TEM analysis. The O isotopic composition differs from that previously reported from a GEMS-rich IDP [6]. Both IDPs could come from different parent bodies.

The available data on potentially cometary IDPs do not indicate that they are all highly ^{16}O-rich as might be expected from self-shielding models. Either these particles are not cometary and come from anhydrous chondrite matrices or the rocky component of comets is much more similar to carbonaceous chondrites than ”predicted”. Stardust will help answer the question whether comet dust is more akin to typical planetary materials or if it truly represents pristine interstellar dust.

References: [1] Clayton R. N. et al. (1973) *Science* 181, 485. [2] Clayton R. N. (1993) *Annu Rev. Earth Planet. Sci.* 21, 115. [3] Clayton R. N. (2002) *Nature* 415, 860. [4] Yurimoto H. and Kuramoto K. (2004) *Science* 305, 1763 [5] Lyons J.R. & Young E.D. (2005) *Nature* 435, 317. [6] Engrand C. et al. (1999) *LPS XXX*, Abstract #1690. [7] Aléon J. et al. (2001) *GCA* 65, 4399. [8] Aléon J. et al. (2003) *GCA* 67, 3773. [9] Clayton R.N. & Mayeda T.K. (1999) *GCA* 63, 2089. [10] Young E.D. & Russell S.S. (1998) *Science* 282, 452. [11] Choi B.-G. et al. (1999) *Nature* 392, 577.

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Figure 1 : Oxygen isotopes in chondritic IDPs. Grey symbols are literature data. Filled symbols are HP data and hollow symbols are HR data. Abbreviations other than in text are as follow : YR – Young and Russell, UOC - Unequilibrated Ordinary Chondrites, CCAM – Carbonaceous Chondrite Anhydrous Minerals, Ol – olivine. For clarity only 1σ error bars on IDP data have been reported