OXYGEN ISOTOPIC INSIGHTS INTO ORIGINS AND HISTORIES OF COMETARY MATERIALS. S. Messenger and L. P. Keller, NASA Johnson Space Center, Astromaterials Research & Exploration Science Division, Robert M Walker Laboratory for Space Science, Houston TX 77058.

Introduction: Originating from the coldest and most quiescent portions of the solar system, comets are likely to be the least processed remnants of the solar nebula. Though once considered to be unprocessed assemblages of interstellar materials, a minor population of crystalline silicates is apparent in some cometary spectra, suggesting that they contain materials processed at high temperatures [1].

Chondritic porous (CP) interplanetary dust particles (IDPs) bear similarities to cometary dust, including their fine grain sizes, fragile microstructures, high abundances of volatile elements and carbon, and anhydrous mineralogy. Infrared spectra of CP IDPs are also a remarkably good match to comets [2]. CP IDPs have been dynamically linked with comets from their high atmospheric entry velocities inferred from thermal release measurements of solar wind He [3].

Here we summarize constraints on the origins of cometary grains derived from oxygen isotopic measurements of submicrometer grains in CP IDPs, acquired with the Washington University NanoSIMS 50 ion microprobe.

Presolar Grains: Circumstellar silicates and oxides have been found in both meteorites and IDPs [e.g. 4-6]. These grains have highly non-solar isotopic compositions, with $^{17}O/^{16}O$ and $^{18}O/^{16}O$ ratios varying by more than 2 orders of magnitude. Most grains apparently derive from red giant and asymptotic giant branch stars, with a minor (~1 %) population from supernovae [7]. Of the few presolar silicates whose mineralogy has been definitively identified by TEM, 4 are amorphous silicates including GEMS grains, and 2 are olivine grains. The mineralogy of presolar silicates is distinctly different from interstellar silicates, that appear to be dominated by amorphous grains.

Silicate stardust grains ARE more abundant in some CP IDPs (450 – 5,500 ppm; 4,8) than in meteorites (<180 ppm; 5,6). Nonetheless, these IDPs are clearly dominated (>99 %) by grains with O isotopic compositions that are so far indistinguishable (within ~50‰) from solar.

Isotopically Solar Crystalline Grains: Crystalline oxides and Mg-rich silicates are common components of CP IDPs. The mineralogy and microstructure of these grains are consistent with condensation from a high T (>1,300 K) gas. Most (>95 %) such grains studied so far have solar O isotopic compositions. It is very likely that most such grains originated in the solar system itself because (1) most oxides and silicates formed around evolved stars have distinctly non-solar O isotopic compositions and (2) crystalline silicates are extremely rare in the interstellar medium (<0.2% of interstellar silicates; 9). These grains probably formed in the inner, warmer regions of the solar nebula, and were transported to the Kuiper belt by turbulence or perhaps the X-wind [10,11].

Isotopically Solar Amorphous Silicates: Amorphous silicates are a major component of CP IDPs, including GEMS grains [12] and other glassy grains. GEMS grains are proposed to have been produced by extensive, gradual sputtering and re-condensation of materials in the ISM [12], a process that would tend to homogenize their chemical and isotopic compositions. Alternatively, these grains may have been late-stage nebular condensates [13], also naturally leaving the grains with solar isotopic compositions.

Because circumstellar silicates tend to have strongly non-solar O isotopic compositions, many interstellar grains will retain distinct isotopic compositions despite extensive mixing with isotopically solar interstellar gas. Among the 1,000 submicrometer grains measured in IDPs so far, less than 1% differ from solar O isotopic composition by more than 50 ‰. If these grains originally had O isotopic compositions similar to circumstellar oxides, their present O isotopic compositions indicate that most of them must have been *thoroughly* homogenized, containing less than 5% of the original stellar condensate. Higher precision O isotopic measurements will be required to identify the expected partially homogenized interstellar silicates that should be marked by moderately anomalous (50 – 100 ‰) isotopic compositions.

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