

HIGH ABUNDANCES OF PRESOLAR SILICATES IN ANTARCTIC MICROMETEORITES; IMPLICATIONS FOR THEIR COMETARY ORIGINS. T. Yada^{1,2,3}, F. J. Stadermann¹, C. Floss¹, E. Zinner¹, T. Nakamura⁴, T. Noguchi⁵, A. S. Lea⁶, ¹Lab. for Space Sciences, Physics Dept., Washington Univ., St. Louis, MO 63130, USA; ²Inst. Astronomy & Astrophysics, Academia Sinica, Taiwan 106, R.O.C.; ³Material Science Division, Argonne National Lab., Argonne, IL 60439, USA (yada@anl.gov); ⁴Dept. Earth & Planetary Sciences, Grad. School of Sciences, Kyushu Univ., Hakozaki, Fukuoka 812-8581, Japan; ⁵Dept. Materials & Biological Sciences, Ibaraki Univ., Mito, Ibaraki 310-8512, Japan; ⁶Pacific Northwest National Lab., Richland, WA 99352, USA.

Introduction: Micrometeorites are the dominant type of extraterrestrial material accreting onto the Earth. Their parent bodies are thought to be asteroids and comets, although the mineralogical and chemical studies indicate that most should have originated from asteroids because of their similarities to carbonaceous (C) chondrites [1, 2]. We previously reported the presence of presolar silicates in Antarctic micrometeorites (AMMs) [3] (note a related correction below). Here, we present a revised abundance of presolar silicates in AMMs and compare it with that of both anhydrous interplanetary dust particles (IDPs) [4, 5], which are thought to be of cometary origin, and C chondrites [6, 7], in order to constrain the parent bodies of AMMs.

Samples and Methods: All AMMs used in this study were collected at Tottuki Point, 17km northeast from Syowa Station, in East Antarctica [8, 9]. Seven fine-grained AMMs, T98NF2, -H3, -H5, -G6, -G8, TT54B397 and T00IBa030, which were identified as AMMs based on SEM-EDS analyses, were analyzed with synchrotron X-ray diffraction (S-XRD) for bulk mineralogy and were then pressed onto the Au foil for NanoSIMS measurements. The analytical conditions used for S-XRD are discussed in [10]. For NanoSIMS, the analytical conditions were presented by [3]. For grains with isotopically anomalous oxygen or carbon, we also analyzed their Si isotopic ratios with the NanoSIMS. Presolar grains were characterized by field-emission SEM-EDS and some were further analyzed by Auger electron spectroscopy [11, 12], in order to determine their elemental compositions.

Results: The total area analyzed by the NanoSIMS was 33000 μm^2 in the seven AMMs. Within this area, eight presolar silicates and one possible presolar SiC grain were discovered from four AMMs. We found two Group 4 [13] presolar silicates in TT54B397 (grains 2P1 and 2P2), three Group 1 presolar silicates in T98H5 (grains 1P1, 4P1 and 15P1), three Group 4 presolar silicates in T98G8 (grains 4P1, 8P1 and 12P1), and a possible presolar SiC grain in T00IBa030 (grain 10P1), as shown in Fig. 1. Oxygen isotopic ratios of the presolar silicates are shown in Fig. 2. C and N isotopic ratios of T00IBa030-10P1 are 22.5 ± 1.6 (normal: 89) in $^{12}\text{C}/^{13}\text{C}$ and 229 ± 40 (normal: 272) in $^{14}\text{N}/^{15}\text{N}$,

indicating that its isotopic ratios are within the range of mainstream SiC grains. Oxygen is normal in the area of T00IBa030-10P1. Despite of isotopic anomaly of O (silicates) or C (SiC), Si isotopic ratios of these presolar grains are, for most part, within the solar range (Fig. 3). The sizes of the presolar grains range from 200nm to 600nm, and Auger spectroscopy results indicate that TT54B397-2P1 and -2P2 are ferromagnesian silicates whereas T98H5-1P1 is an Fe-rich silicate. The Auger identification of the possible SiC, T00IBa030-10P1, was inconclusive. Although there is clear C enrichment in the region of the grain, O, Mg and Fe were also detected. It is likely that it is almost consumed by the NanoSIMS measurements.

Discussions: Based on the cross-section areas of AMMs analyzed, the abundance of the presolar silicates in AMMs has been revised to be 50 ppm. For three presolar-silicate-bearing AMMs, TT54B397, T98H5, and -G8, the abundance of presolar silicates is as high as 130 ppm. In the AMM with the largest concentration of presolar silicates, TT54B397, the abundance is 900 ppm. Recent studies reported that the abundance of presolar silicates in primitive IDPs is ~ 400 ppm [5] and that it ranges from 40 to 110 ppm in C chondrites [6, 7]. Although the total abundance of presolar silicates in AMMs is comparable to that of C chondrites, a subgroup of the AMMs has significantly higher abundances. AMM TT54B397 has a presolar silicate abundance which is similar to that of primitive IDPs, suggesting that the AMMs enriched in presolar silicates might be of cometary origin. Moreover, the AMMs (T00IBa030, T98H3 and -G6) in which no presolar silicates have been observed shows diffraction peaks of magnesiowustite, which is considered to have formed by the decomposition of carbonates, phyllosilicates, or magnesites, whereas presolar-silicates-bearing AMMs (TT54B397, T98H5 and -G8) shows no diffraction peak for this mineral. Those precursor minerals are common in C chondrites, but are not observed in anhydrous IDPs. This indicates that the magnesiowustite-bearing AMMs may have originated from parent bodies similar to those of C chondrites, whereas AMMs without magnesiowustite may originally have been composed of anhydrous phases, like anhydrous IDPs.

References: [1] Kurat G. et al. (1994) *GCA*, 58, 3879-3910. [2] Noguchi T. et al. (2002) *EPSL*, 202, 229-246. [3] Yada T. et al. (2005) *LPS XXXVI*, #1227. [4] Messenger S. et al. (2003) *Science* 300, 105-108. [5] Floss C. and Stadermann F. J. (2004) *LPS XXXV*, #1281. [6] Nguyen A. N. and Zinner E. (2004) *Science*, 303, 1496-1499. [7] Mostefaoui S. and Hoppe P. (2005) *ApJ*, 613, L149-L152. [8] Yada T. and Kojima H. (2000) *Antarct. Meteorite Res.*, 13, 9-18. [9] Iwata N. and Imae N. (2002) *Antarct. Meteorite Res.*, 15, 25-37. [10] Nakamura T. et al. (2001) *GCA*, 65, 4385-4397. [11] Stadermann F. J. et al. (2005) *Meteorit. Planet. Sci.*, 40, A146. [12] Stadermann F. J. et al. (2006) *this conference*. [13] Nittler L. R. et al. (1997) *ApJ*, 483, 475-495.

Correction: In the abstract from last year's LPSC [3], we reported that an anomalous isotopic feature found in AMM AWU01-16 appears to be of presolar origin. However, further analyses of AWU01 AMMs indicate that the isotopic feature was an artifact due to the earlier implantation of O by the ims3f ion microprobe. Thus, we have excluded AWU01-16 grain C-3P1 from the list of presolar silicates.

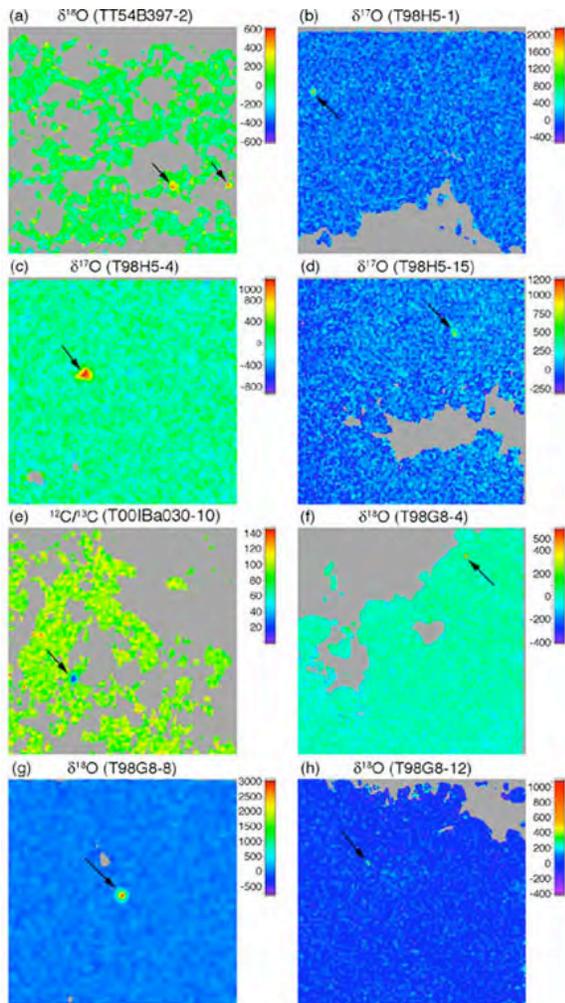


Fig. 1. O and C isotopic ratio images of AMMs containing isotopically anomalous grains. The area of (c), (e) and (g) are

10x10 μm^2 and the others are 20x20 μm^2 . The grains indicated by black arrows have isotopic ratios outside the solar range. Eight presolar silicates, TT54B397-2P1 (a, left) and -2P2 (a, right), T98H5-1P1 (b), T98H5-4P1 (c), T98H5-15P1 (d), T98G8-4P1 (f), T98G8-8P1 (g), and T98G8-12P1 (h), and a possible presolar SiC, T001Ba030-10P1 (e) are observed in the images.

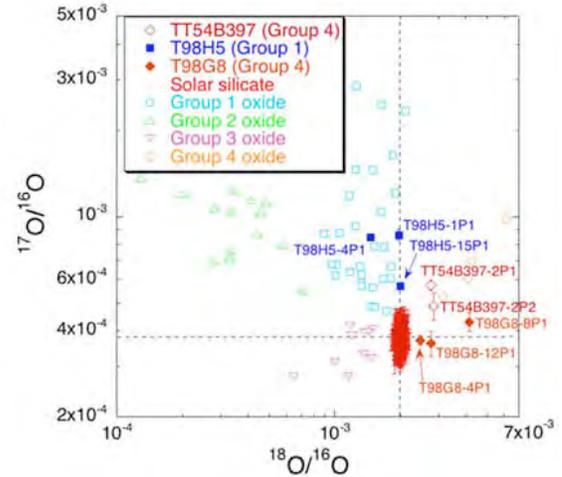


Fig. 2. Oxygen isotopic ratios of eight presolar silicates observed in AMMs. Error bars are 1 σ . Data for presolar Al₂O₃ grains are plotted for comparison [13].

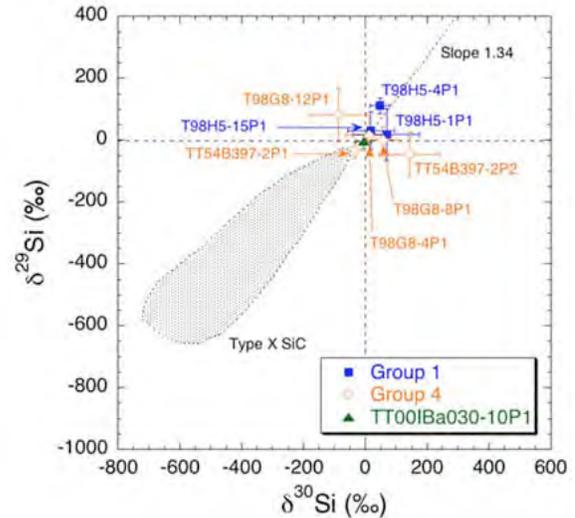


Fig. 3. Silicon isotopic ratios of presolar silicates and a possible SiC in AMMs. Error bars are 1 σ . All of the presolar grains except for T98H5-4P1 have solar isotopic compositions within errors.