NANOSIMS STUDIES OF DUST FROM SUPERNOVAE.

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Introduction: Primitive Solar System materials contain small quantities of refractory dust grains that are older than our Solar System. These so-called presolar grains exhibit large isotopic anomalies in major and minor elements. Presolar grains formed in the winds of evolved stars and in the ejecta of supernovae (SNe) and novae, i.e., they represent a sample of stardust that can be analyzed in terrestrial laboratories [1]. Among the identified presolar grains are nanodiamonds, silicon carbide (SiC), graphite, silicon nitride (Si_3N_4), oxides, and silicates. Here, I will focus on NanoSIMS studies of SiC, oxide, and silicate grains from SNe.

NanoSIMS: An important tool for the study of presolar grains is the NanoSIMS ion probe [2]. This secondary ion mass spectrometer permits isotope measurements of the light and intermediate-mass elements at the sub-micron scale. A key feature of the NanoSIMS is ion imaging, a technique that permits to identify specific types of presolar grains in grain mounts [3; 4] or in-situ in thin sections of primitive Solar System materials [e.g., 5]. This has been specifically important for the identification of rare SN grains.

Supernova Dust: Silicon carbide grains from SNe are so-called Type C and X grains [1] (Fig. 1). These grains comprise about 1 % and 0.1%, respectively, of all SiC grains. Also some of the putative nova grains might be from SNe. C and X grains grains have mostly higher than solar $^{12}C/^{13}C$ and lower than solar $^{14}N/^{15}N$ (Fig. 1). A significant fraction of C grains also have very low $^{12}C/^{13}C$ ratios of <10 [6]. C grains show excesses in the heavy Si isotopes while X grains have excesses in ^{28}Si. The SiC SN grains incorporated radioactive ^{26}Al (half life 716’000 a), ^{32}Si (half life 153 a), ^{44}Ti (half life 60 a), and ^{49}V (half life 330 d) when the grains formed [e.g., 7-12]. X grains may also carry neutrino-process boron, as inferred from small ^{11}B excesses [13]. A comparison of C and X grain data with SN model predictions [14; 15] reveals good agreements but also several problems.

Oxides and silicates from SNe are so-called Group 4 grains, some of the Group 3 grains, and two ^{16}O-rich grains [1] (Fig. 2). O-rich SN grains may comprise as much as 20 % by mass of all O-rich presolar grains [16]. The most ^{18}O-rich grain is an olivine found in an IDP [17]. The proposed SN origin of the ^{18}O-rich Group 4 grains is supported by an excellent agreement between multi-element isotope data and SN model predictions [18]. An ^{16}O-rich spinel grain incorporated radioactive ^{44}Ti at the time of grain formation [4] and large ^{54}Cr excesses of presumably SN origin are associated with small (<100 nm) spinel grains [19; 20].

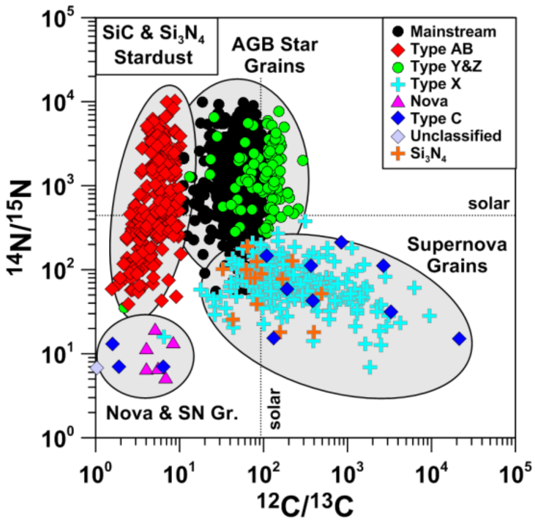

Figure 1. Nitrogen- and C-isotopic compositions of presolar SiC and Si_3N_4 grains. Distinct SiC populations are indicated by the different symbols. Data taken from the WU Presolar Grains Data Base [21] and from [6; 22].

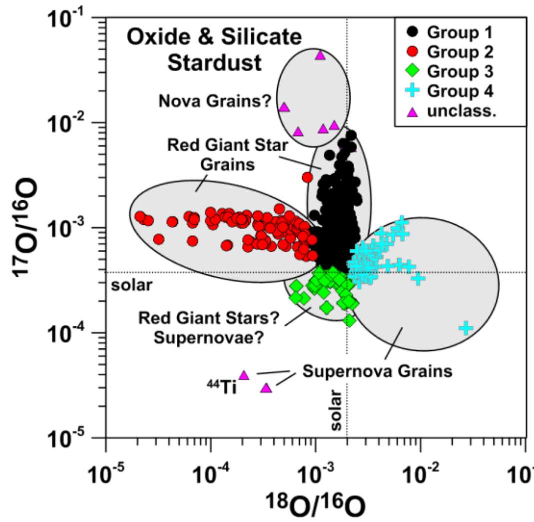

Figure 2. Oxygen-isotopic compositions of presolar oxide and silicate grains. Distinct O isotope groups are indicated by different symbols. Data taken from the WU Presolar Grains Data Base [21].

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