Ti-44 AND V-49 IN SIC GRAINS OF TYPE X REVISITED. E. Zinner[1], F. Gyngard[1], and Y. Lin[2], [1]Laboratory of Space Sciences and the Physics Department, Washington University in St. Louis, One Brookings Dr., St. Louis, MO 63130, USA., ekz@wustl.edu, [2]Key Laboratory of the Earth's Deep Interior, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China.

Introduction: Presolar SiC grains of type X have large ^{28}Si excesses, indicative of an origin in Type II supernovae [e.g., 1, 2] since SNe produce Si with large ^{28}Si excesses in the innermost zones [e.g., 3]. A SN origin is confirmed by evidence for radiogenic ^{44}Ca from the decay of ^{44}Ti in some X grains [4, 5]. Many X grains also exhibit large ^{49}Ti excesses, which Hoppe and Besmehn [6] attributed to the decay of short-lived ^{49}V. ^{44}Ti and ^{49}V are both found in the ^{28}Si-rich Si/S zone [3]. Motivated by Ca and Ti isotopic measurements in X grains from the Qingzhen meteorite [7], we are revisiting ^{44}Ti and ^{49}V and ask whether there are differences between two sub-classes of X grains, X1 and X2. Type X1 grains have Si isotopic ratios that plot along a line of slope ~0.65 in a δ-value Si 3-isotope plot, whereas X2 grains plot below this line [8]. In our comparison of the X grain data we do not limit ourselves to the Qingzhen grains but consider all available X grain data [9].

Discussion: Figure 1 shows Si, Ti and V isotopic ratios in the inner zones of the 25M⊙ SN model by Rauscher et al. [3]. These are the zones that contain the short-lived nuclides ^{44}Ti and ^{49}V. Ratios of stable isotopes are normalized to their solar ratios. The ^{28}Si excesses in X grains require contributions from these zones. The C and N isotopic ratios in the grains, on the other hand, require material from the He/N and He/C zones. Here we try to explain the Si, Ti, and V isotopic ratios of X grains by mixing of material from these different zones.

First, we investigate whether ^{49}Ti excesses can be explained by the decay of ^{49}V. In Fig. 2a we show a plot of inferred ^{49}V/^{51}V versus inferred ^{44}Ti/^{48}Ti ratios under the assumption that all ^{49}Ti excess originates

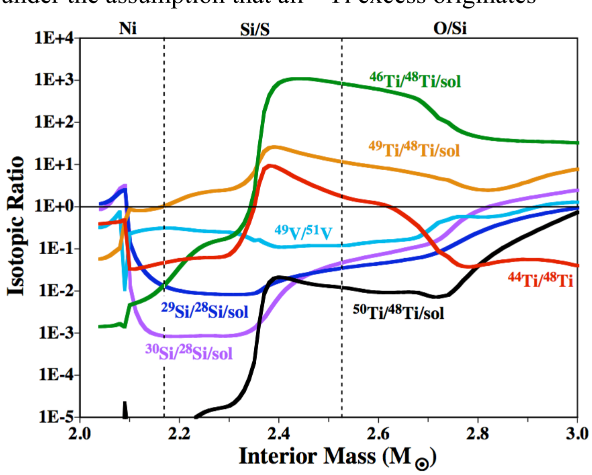

Figure 1

from ^{49}V decay and compare these ratios with theoretical predictions. The diamonds are the ratios for the layers between 2.05 and 3M⊙ interior mass of the 25M⊙ SN model of [3]. The lines show compositions for mixtures with C>O, required for SiC condensation, between various inner layers and a H/N-He/C mixture that gives ^{12}C/^{13}C=100. As can be seen, most of the grain data plot above compositions that can be obtained by the mixtures, indicating that not all the ^{49}Ti excesses in X grains are due to ^{49}V decay. As a matter of fact, the H/N-He/C mix we used for the mixing curves has a δ^{49}Ti/^{48}Ti value of 522‰ due to neutron capture in the He/C zone [3].

In Fig. 2b we plot the δ^{49}Ti/^{48}Ti values of X grains against their inferred ^{44}Ti/^{48}Ti ratios together with mixing curves obtained in the same way as in Fig. 2a. The plot shows that the ^{49}Ti excesses of almost half of the grains can be accounted for by n-capture in the He/C zone and no contributions from ^{49}V decay are required. Our assumed He/N-He/C mix has ^{12}C/^{13}C=100. However, many grains have larger ratios (numbers next to the data symbols in Fig. 2b), implying higher ^{49}Ti/^{48}Ti ratios because of a larger fraction of He/C material in the He/N-He/C mix. Thus it seems that most of the ^{49}Ti excesses can be explained by n-capture in the He/C zone and ^{49}V decay is needed only for a few grains.

In Fig. 2c and d we plot also ^{46}Ti/^{48}Ti ratios. Plot d contains more data points than plot c because ^{44}Ti/^{48}Ti data are limited. We note that several grains have large ^{46}Ti deficits and even ^{49}Ti deficits. ^{46}Ti deficits can be explained by admixture from the inner Si/S zone (Fig. 1), but ^{49}Ti deficits are more difficult to explain. From Figs. 2c and d it is apparent that any contributions from layers ≥2.4M⊙ in interior mass would result in a large ^{46}Ti excess, which is seen in only one grain. This indicates only small contributions from the outer Si/S and inner O/Si zone, a conclusions also reached from the lack of large ^{54}Fe excesses in X grains [10].

Fig. 3 shows that X2 grains have higher inferred ^{44}Ti/^{48}Ti ratios than X1 grains. Although a correlation between ^{44}Ti/^{48}Ti ratios and Si isotopic ratios is expected since the zones containing ^{44}Ti are rich in ^{28}Si, such a correlation is observed only for the ^{29}Si/^{28}Si ratio (Fig. 3a). In Fig. 3, we also show (only for C>O) curves obtained by mixing a He/N-He/C mix having ^{12}C/^{13}C=390, ^{14}N/^{15}N=100, δ^{29}Si/^{28}Si=800‰, and δ^{30}Si/^{28}Si=1,100‰ with material from different layers of the Ni, Si/S, and O/Si zones. Only the ratios in X1 grains can be reproduced in this way; most X2 grains plot above the mixing curves. Their ^{44}Ti/^{48}Ti ratios can be reached by mixing with the layer at 2.4M⊙ interior

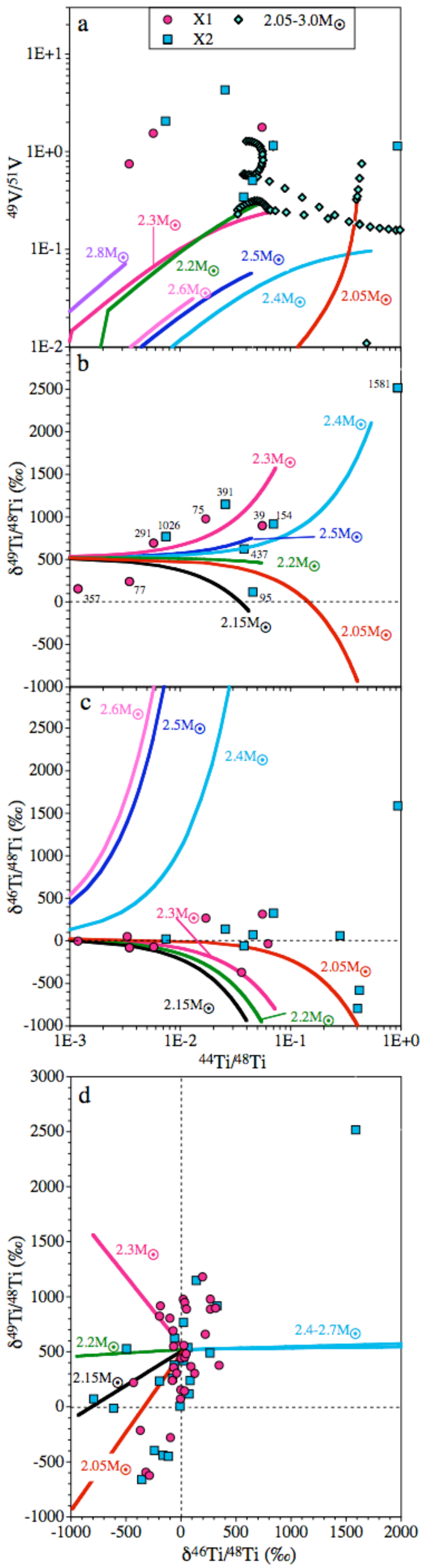

Figure 2

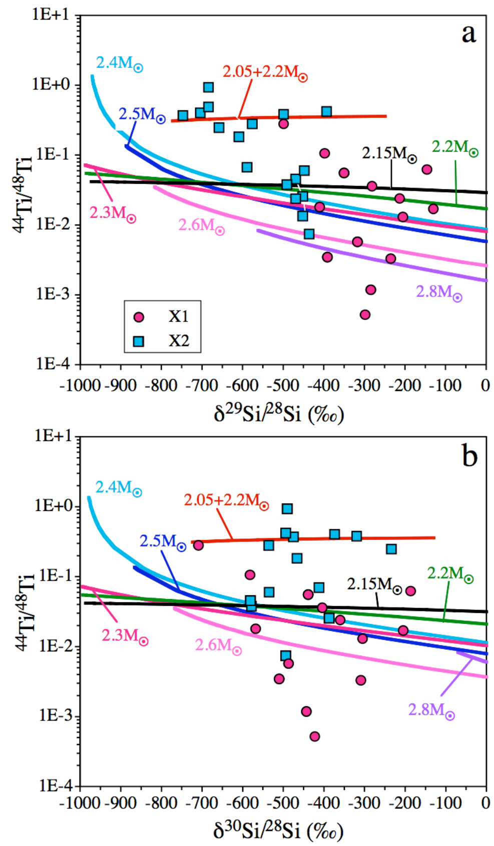

Figure3

mass, where this ratio is highest (Fig. 1); however the corresponding Si isotopic ratios are much smaller than those in the grains. The layer at 2.05M⊙ interior mass does not have a ^{28}Si excess (Fig. 1) but has very little Si. Since it contains a lot of ^{44}Ti, we can achieve the high $^{44}Ti/^{48}Ti$ ratios and the Si isotopic ratios observed in most X2 grains by combining contributions from this layer and from ^{28}Si-rich layers in the Si/S zone. For example, the curves labeled "2.05+2.2M⊙" in Fig. 3 are obtained by mixing 10% from the 2.05M⊙ and 0.6 to 3% from the 2.2M⊙ layer with the remaining fraction from the He/N-He/C mixture previously described. This confirms the conclusion [2] that contributions from the Ni core are needed in order to account for the high $^{44}Ti/^{48}Ti$ ratios of some X grains, particularly those of type X2..

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