ASYMPTOTIC GIANT BRANCH STARS AND THEIR INFLUENCE ON THE ISOTOPIC COMPOSITIONS OF THE TRANSITION ELEMENTS. A. M. Davis¹, R. Gallino², S. Cristallo³, and O. Straniero³. ¹Department of the Geophysical Sciences, Enrico Fermi Institute, University of Chicago, Chicago, IL 60637, USA. E-mail: a-davis@uchicago.edu. ²Dipartimento di Fisica Generale, Università di Torino, 10125 Torino, Italy. ³INAF-Osservatorio Astronomico di Collurania, 64100 Teramo, Italy.

The great majority (~90%) of presolar SiC grains likely come from low mass (~2 M☉) asymptotic giant branch (AGB) stars, the site of s-process nucleosynthesis. Progressive leaching experiments on carbonaceous chondrites have revealed s-process signatures, due to the chemical resistance of SiC [e.g., 1, 2]. With the increasing interest in nucleosynthetic anomalies in the transition elements in bulk meteorites and in leachates of primitive meteorites [e.g., 3–5], as well as in individual presolar SiC grains [6] we examine the predictions of AGB star models for these elements.

The envelope of an AGB star of initially solar composition has C< O in the early stages and condenses silicates and oxides. With repeated thermal pulses with dredge-up from the He inter-shell, the envelope becomes enriched in carbon and s-process isotopes. Once the C/O > 1, graphite and carbides begin to condense in stellar winds. In order to compare calculations with leaching residues from meteorites, we constructed a weighted average isotopic composition of graphite and carbides condensing from the envelope, weighting each pulse with C/O by the amount of mass loss following each pulse. This average is dominated by the last pulse with dredge-up, after which about half of the envelope is eventually lost through stellar winds. Isotopic compositions predicted for average graphite and carbides condensed from an AGB star of 2 M☉ and initial solar metallicity follow (with cross sections mostly slightly updated from [7], but with important changes for Ni, Cu and Ge): (1) $\delta^{(46\text{Ti}^{48}\text{Ti})}=36\%$, $\delta^{47}\text{Ti}=8\%$, $\delta^{49}\text{Ti}=96\%$, and $\delta^{50}\text{Ti}=168\%$; (2) $\delta^{(50}\text{Cr}^{52}\text{Cr})=-18\%$, $\delta^{53}\text{Cr}=1\%$, and $\delta^{54}\text{Cr}=72\%$; (3) $\delta^{(54}\text{Fe}^{56}\text{Fe})=-4\%$, $\delta^{57}\text{Fe}=54\%$, $\delta^{58}\text{Fe}=282\%$, and $\delta^{56}\text{Fe}^{58}\text{Fe}=2.8\times10^{-6}$; (4) $\delta^{(58}\text{Ni}^{58}\text{Ni})=17\%$, $\delta^{59}\text{Ni}=142\%$, $\delta^{60}\text{Ni}=59\%$, and $\delta^{61}\text{Ni}=450\%$; (5) $\delta^{(63}\text{Cu}^{65}\text{Cu})=521\%$; (6) $\delta^{60}\text{Zn}^{64}\text{Zn})=270\%$, $\delta^{62}\text{Zn}=430\%$, $\delta^{64}\text{Zn}=564\%$, and $\delta^{60}\text{Zn}^{64}\text{Zn}=13\%$; (7) $\delta^{71}\text{Ga}^{71}\text{Ga})=355\%$; (8) $\delta^{72}\text{Ge}^{70}\text{Ge})=94\%$, $\delta^{73}\text{Ge}=40\%$, $\delta^{75}\text{Ge}=109\%$, and $\delta^{76}\text{Ge}=640\%$. All s-only isotopes below A=90 are dominated by production in the preexplosion evolution of massive stars, but a number of isotopes, including $^{58}\text{Fe}$, $^{64}\text{Ni}$, $^{65}\text{Cu}$, $^{66,67,68}\text{Zn}$, $^{69}\text{Ga}$, and $^{70,72,73,74}\text{Ge}$, have some production in AGB stars. Progressing through the sequence of elements listed above, there is increasing overproduction of s-process isotopes, but even with $^{70,72,73,74}\text{Ge}$, only half as much overproduction in AGB stars as is typical for s-only isotopes of mainly AGB parentage such as $^{96}\text{Mo}$ and $^{134}\text{Ba}$.

The largest predicted anomalies in Fe and Ni are in $^{58}\text{Fe}$ and $^{64}\text{Ni}$, isotopes that are often ignored because of low abundances and isobaric interferences. It is of great importance to measure all isotopes to fully understand nucleosynthetic histories.