Correlation of ^{48}Ca-^{50}Ti-^{54}Cr isotopic anomalies among meteoritic materials

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Neutron-rich isotopic heterogeneities in low mass side iron peak elements, namely ^{48}Ca, ^{50}Ti, and ^{54}Cr, have been discovered to be endemic in the solar system from a scale of small Ca-Al rich inclusions (CAIs) to bulk asteroids [1-6]. Current theory suggests that interstellar ^{48}Ca was contributed from neutron rich type-Ia supernovae (nSNe Ia). Therefore, it could help an understanding of the stellar nucleosynthesis mechanism in nSNe Ia by determining the correlation of ^{48}Ca, ^{50}Ti, and ^{54}Cr if all these anomalous effects were contributed from the same stellar source (nSNe Ia) and carrier phases, and no chemical fractionation occurred during solar system formation.

Bulk meteorite analyses on these isotopes reveal that their anomalies are consistent within the same meteorite groups except for carbonaceous chondrites (CC) and eucrites,. Therefore, it is reasonable to use the average anomalies of a group to compare ^{48}Ca, ^{50}Ti, and ^{54}Cr correlations, and establish a linear regression indicating mixing with a component of nSNe Ia, with ignition density ~5.8-7.4×10^9 g/cm^3. Variable ^{50}Ti anomalies of the same bulk CC reported from different studies might reflect imhomogeneities of ^{50}Ti at a range of scales. Therefore, it is unclear whether such isotopic anomalies are uniform within the same group of CC. In particular, samples of CV chondrites likely contain variable relative abundances of CAIs, in which ^{50}Ti anomalies are variable but ^{48}Ca anomalies remain within a narrow range. These variable ^{50}Ti anomalies, uncorrelated with ^{48}Ca anomalies among normal CAIs were suggested to reflect contributions from two different stellar nucleosynthesis sites, nSNe Ia, and O/Ne-O/C layer of type-II supernovae (SNe II). Therefore, variable ^{48}Ca/^{50}Ti anomalies in CAIs result in different slopes on ^{48}Ca-^{50}Ti regression lines depending on whether or not CAIs are included, and the specific compositions of the included CAIs. [6].

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