CA ISOTOPIC ANOMALIES IN CAIS. H. W. Chen[1], T. Lee[1,2], D. C. Lee[1] and J. C. Chen[1], [1]Institute of Earth Sciences, Academia Sinica, Taipei, Taiwan, ROC (haart@earth.sinica.edu.tw), [2]Institute of Astronomy & Astrophysics, Academia Sinica, Taipei, Taiwan, ROC.

Introduction: Meteoritic Ca-Al rich inclusions (CAIs) were thought to be the oldest and most primitive objects formed in the infant solar system. This means that they are isolated from solar system accreting processes in very early epoch and have some opportunities to preserve isotopic signatures in pre-solar grains that reflect stellar nucleosynthesis characteristics of their forming region. Calcium, the major element in CAIs, is one of the earliest elements to condense and/or crystallize in the solar system, or perhaps the last residue of pre-solar material to evaporate because of its refractory behavior. Also, six calcium stable isotopes (^{40}Ca, ^{42}Ca, ^{43}Ca, ^{44}Ca, ^{46}Ca, and ^{48}Ca) are produced by at least three nucleosynthetic processes: s-process, α-rich freeze-out, and nuclear statistical equilibrium. Hence studying calcium isotopic composition in CAIs can help to decipher those pre-solar signals preserved in CAIs. Early Ca isotopic works had recognized distinct neutron-rich ^{48}Ca anomaly in CAIs, after normalizing to terrestrial normal ^{40}Ca/^{44}Ca [1-3]. The significant ^{48}Ca suggests a neutron rich nuclear statistical equilibrium (nNSE) products existed in the early solar system that is most likely from a neutron-rich type Ia supernovae explosion event [4].

Except ^{48}Ca, the other isotopes, such as ^{42}Ca, ^{43}Ca and ^{46}Ca, also show slightly isotopic anomalous effects in few CAIs. However, limited by instrumental analytical performance, those effects are not well resolvable. In this abstract, we report our Ca isotope results of CAIs with sub-epsilon (ε; in parts per 10^4) level of analytical precision that are capable to recognize/verify those Ca isotopic anomalies reported by early works.

Results and Discussion: All analyzed CAIs results show resolvable endemic ^{43}Ca/^{44}Ca anomaly (as high as 5σ effect). The possible interference of ^{27}Al^{16}O has been carefully checked by monitoring ^{27}Al^{18}O species with electronic multiplier that the limit of 1 count per minute is not high enough to account for the size of the effect found here. There is no resolvable ^{40}Ca/^{44}Ca anomaly on most of analyzed CAIs except one which preserves *ca.* 4σ excess effect. None of CAIs have resolvable ^{46}Ca/^{44}Ca anomaly ($<8\varepsilon$). The observed ^{43}Ca/^{44}Ca does not establish a simple correlation with the other well resolvable ^{48}Ca/^{44}Ca anomaly and supports the theoretical prediction that they are contributed from different nucleosynthesis sources.

^{43}Ca may be enriched by s-process during explosion carbon burning with seed nuclei [5], however, theoretical calculation predicts two order of magnitudes larger ^{46}Ca anomaly that is not found in CAIs. Nucleosynthesis in a two solar mass AGB phase can also yield ^{43}Ca relative more than ^{42}Ca and ^{44}Ca to make ^{43}Ca/^{44}Ca excess [6], but capturing neutron will significantly deplete dominant ^{40}Ca isotope that is also not supported from meteoritic measurements. Ejecta from core-collapse Type II supernovae with different initial stellar mass show that materials from oxygen-carbon layer are capable to produce observed ^{43}Ca excess relative to ^{42}Ca and ^{44}Ca while ^{40}Ca and ^{46}Ca remaining close to normal ratios. Under this scenario, supernovae ejecta from different layers have to be mixed inefficiently to avoid extremely abundant ^{46}Ca enrichment in other layers.

While endemic ^{48}Ca/^{44}Ca excess are preserved in normal CAIs, on the other hand, different clasts of meteorites, including of ureilites, HEDs, angrites, enstatite chondrites and most of ordinary chondrites all show ^{48}Ca/^{44}Ca deficits that are consistent within the same group and correlated with ^{50}Ti and ^{54}Cr [7]. This implies planetary scale of ^{48}Ca heterogeneity, however, how to preseve the observed heterogeneity in those differentiated parent bodies? A speculative idea is while a type Ia supernova explodes, most of the time the entire star was fused to essentially iron group elements including of ^{48}Ca, ^{50}Ti and ^{54}Cr. Therefore the ejecta should be pure metal. Under such an unusual circumstance (almost the only place in the universe that is free from the first 6 most abundant elements: H, He, C, N, O, & S), Ca and Ti may have been incorporated in an extraordinary form, hence, the rare nuclear component from the rare neutron-rich type Ia supernova could have been carried by dust with unique chemical and physical properties. When the rare and unusual dust arrived at the solar nebula, their interaction with, for example, solar magnetic field, to cause the nuclear component to enter the planetesimals non-uniformly to preserve isotopic heterogeneity in several hundreds of kilometer size of molten planetary objects at several AUs apart.

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