Ca ISOTOPIC ANALYSIS AS A TOOL FOR EXPLORING GENETIC RELATIONSHIPS AMONG ACHONDRITES

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Introduction: Lord Kelvin probably would put a meteoritics as a "stamp collection" science. In this paper we aim to evaluate the potential of helping this endeavor by using the widespread ^{48}Ca anomalies.

Method: Ca was extracted by conventional cation exchange. For each run 2μg Ca was analyzed by double filament TIMS. Four runs were binned to yield one grand mean that is shown in Fig. 1. NIST SRM 915a was used as the normal standard. Two standard deviations of the population (2σ) consisting of 18 such grand means were measured over 6 months to test our long term reproducibility. They were found to be 0.87, 0.13, 4.6, and 0.42ε for ^{40}Ca/^{44}Ca, ^{43}Ca/^{44}Ca, ^{46}Ca/^{44}Ca, and ^{48}Ca/^{44}Ca after correcting for instrumental fractionation by normalizing ^{42}Ca/^{44}Ca to 0.31221. A plagioclase sample from the Uzen volcano, Japan, was processed the same way as meteorites samples. Fig. 1 plots the deviation of ^{48}Ca/^{44}Ca relative to the normal which is represented by the average of all 18 grand means of SRM 915a. Each symbol is the grand mean of 4 runs. The two Uzen results agree with each other and normal within 0.2ε. For each sample we take the long term reproducibility or 2σ of 4 runs which is greater. To further test our ability to resolve epsilon level of isotope shift.

Ca-48 anomalies: 2~4 meteorites from each of the 5 classes of achondrites were studied. Meteorites in the same class seem to share the same characteristic ε^{48}Ca isotopic shift. Ureilite, diogenite, angrites, eucrites, and Martian meteorites show ε^{48}Ca of -2.0, -1.6, -1.2, -0.9 and -0.1ε respectively. Previously δO were used most successfully in classifying meteorites. Our preliminary data show that ε^{48}Ca is probably as effective as δO. Moreover, e^{48}Ca may carry different record than δO. An interesting example is ureilite. Among achondrite, ureilite was thought to be related to carbonaceous chondrites, indeed, their δO fall on the same 1:1 line. However, all four ureilites have ε^{48}Ca around -2±0.5ε while the only whole rock ε^{48}Ca data for carbonaceous chondrite seems to show effect of opposite direction (+5±2ε) [1].

References: *[1] Chen J. H. et al. 2011. LPSC 42:A2440.*

Fig. 1