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COSMOGENIC ^{36}Ar FROM NEUTRON CAPTURE BY ^{35}Cl IN THE CHICO L6 CHONDRITE: ADDITIONAL EVIDENCE FOR LARGE SHIELDING; D.H. Garrison, D.D. Bogard, (NASA, Johnson Space Center, Houston, TX 77058) & G.F. Herzog (Rutgers Univ., New Brunswick, NJ 08903).

The cosmic-ray-produced ^{36}Ar/^{38}Ar ratio measured in iron meteorites is ~0.65 but is not well determined for stone meteorites due to the common presence of trapped Ar or adsorbed atmospheric Ar in bulk analyses. Almost all single-extraction measurements of stones give ^{36}Ar/^{38}Ar ratios intermediate between the trapped and air values of 5.3 and the expected cosmogenic value of ~0.65 (1). Cosmic ray interactions produce ^{36}Ar directly and through the ^{36}Cl precursor (half-life, 3x10^{5} yrs). The high-energy production rate of ^{36}Cl in chondrites is predicted to be 3-8 atoms/min/kg (2), and virtually all of the limited ^{36}Cl measurements in chondrites are within this range (3). Theoretically, ^{36}Cl can also be produced in significant amounts in large meteorites by thermal neutron capture on ^{35}Cl (2). Except for Allende (4), significant excesses of ^{36}Cl and/or cosmogenic ^{36}Ar attributable to neutron capture have not been reported for any chondrite, including samples of variable shielding from large chondrites. The Chico L6 chondrite is a good candidate for observing cosmogenic ^{36}Ar produced by neutron capture because: 1) it had a long irradiation under very large shielding (5); 2) an impact ~0.5 Ga ago strongly degassed it of radiogenic ^{40}Ar and presumably any trapped Ar as well; 3) measurements of ^{37}Ar and ^{38}Ar by stepwise temperature degassing of neutron-irradiated Chico samples define the release of cosmogenic Ar produced from Ca in relation to neutron-capture Ar produced from Cl sites; and 4) we determined the [Cl] for the irradiated samples.

The isotopic composition of Ar was measured for stepwise temperature release of both chondritic and melt portions of Chico. For the neutron-irradiated samples, most of the ^{37}Ar and ^{38}Ar (produced in the reactor from Ca and ^{37}Cl, respectively), and most of the cosmogenic ^{36}Ar were released at relatively high extraction temperatures of 1100-1600°C, suggesting that Cl contamination is not significant. From the reaction ^{37}Cl (n,γ β) ^{38}Ar and a determination of [Cl] in our flux monitor, we calculate [Cl] for the chondrite and melt samples of Chico as 77ppm and 84ppm, respectively. For the two unirradiated Chico samples, cosmogenic ^{36}Ar and ^{38}Ar were also primarily released at 1100-1500°C. However, the cosmogenic ^{36}Ar/^{38}Ar ratio varied considerably during the releases, reaching high values around 1000°C of 4.4 and 9 for the chondritic and melt samples, respectively, and dropping to low values around 1400°C of 1.2-1.3. The variation in ^{36}Ar/^{38}Ar was essentially that expected from the relative releases of ^{38}Ar (from Cl) and ^{37}Ar (from Ca) in irradiated samples, and indicates the presence of both high-energy and neutron-capture components for ^{36}Ar. Values greater than ~5.3 can only be produced from Cl. The average cosmogenic ^{36}Ar/^{38}Ar for the chondritic and melt samples (after small corrections for low-temperature air Ar and ^{38}Ar from probable Cl weathering products) were 1.76 and 2.27, respectively. The maxima in ^{36}Ar/^{38}Ar for the unirradiated samples occurred at approximately the same extraction temperature as maxima in ^{38}Ar/^{37}Ar for the irradiated samples. These data demonstrate that the cosmogenic ^{36}Ar/^{38}Ar ratio in Chico is much higher than the typical value accepted for chondrites of ~0.65-0.7.

Assuming a high-energy spallation ratio of ^{36}Ar/^{38}Ar =0.65, we calculate excesses of ^{36}Ar produced by neutron capture on ^{35}Cl for the chondritic and melt samples of 2.6 x10^{-8} and 3.4 x10^{-8} ccSTP/g, respectively. For a cosmic ray exposure age for Chico of 63 My (5), these ^{36}Ar excesses correspond to a ^{36}Ar production rate by thermal neutron capture of ~300 atoms/minute/gram-Cl. By way of comparison, (4) observed an average excess of ^{36}Ar in their Allende samples of ~2x10^{-8} ccSTP/g and an average [Cl] of 2800ppm, which yields an average ^{36}Ar production rate (with Allende exposure age = 5.2 My) of ~70 atoms/min/g-Cl. For chondrites this calculated production rate (2, 6) rises from essentially the spallation-produced value at no shielding to values of 200-275 atoms/min/g-Cl or more at shielding levels of ~300 g/cm^{2} in large meteorites. Because bulk analyses of most chondrites yield measured ^{36}Ar/^{38}Ar ratios higher than the assumed cosmogenic value of ~0.65, the ^{38}Ar is corrected for trapped (or atmospheric) Ar using assumed end-member components and the lever rule. The Chico data suggest that for large chondrites the cosmogenic ^{36}Ar/^{38}Ar ratio may well be significantly higher than 0.65 and therefore such a procedure may underestimate the concentration of cosmogenic ^{38}Ar. In this context we note that in analyses of many Antarctic chondrites (7) observed that determined amounts of cosmogenic ^{38}Ar averaged ~13% too low in comparison to that expected from measurements of other cosmogenic species. Measurement of ^{36}Cl in Chico is planned.

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