APATITE CONTROL OF CHONDRITIC ACTINIDE CHEMISTRY? J.S. Goreva and D.S. Burnett, California Institute of Technology, GPS, 100-23, Pasadena, CA, 91125 (julia@gps.caltech.edu)

The solar system Th/U is regarded as about 3.7, and ratios close to this are directly measured in a wide variety of planetary materials. Consequently, given that chondritic composition is regarded as solar for refractory lithophile elements, it is surprising that some ordinary chondrites show high ratios (6 to 6.5). We set out to understand the origin and implications of these anomalies, first by establishing that we had samples of the anomalous material using high accuracy isotope dilution, ICPMS measurements of Th/U. Our 3 samples of Glatton (L6) were not anomalous (Th/U from 3.71 to 3.84), but for 12, typically gram-sized, samples of Harleton (L6) we find a range of Th/U from 2.5 to 6, a greater range of Th/U in one meteorite than in all previous ordinary chondrite analyses. Moreover, the Figure shows: (1) the Th/U variations linearly correlate with 1/U, suggesting two component mixing; (2) other literature analyses follow the Harleton trend.

It is well known that U and Th are concentrated in apatite and merrillite in ordinary chondrites with distinct Th/U (Figure). One would expect that mixtures of these phases with inert material would produce wide scatter on the Figure. The observed correlation is thus a surprise. However, a simple mixing model (line in Figure) describes the trend well by assuming: (a) apatite is the high-U component; (b) the low U component is merrillite c) a fixed-proportion mixture of 1% total phosphate and inert material. Variations in apatite/merrillite (0.3-0.03) with fixed total phosphate content produce the trend. Supporting this interpretation, we observe a high modal apatite/merrilite for Harleton relative to average chondritic proportions. Petrogenetically, Cl appears to control the U, and to a lesser extent, Th, distributions. The heterogeneous Cl distribution in ordinary chondrite parent bodies causes the Th/U variations. Somewhat ironically, the distribution of a low Th/U phase (apatite) explains the high Th/U anomalies!

Rocholl and Jochum (EPSL 117, 265-278, 1993) previously found a similar correlation as the Figure for carbonaceous chondrites, but with different lines for CI, CM, and CV. They suggested apatite as the high U component and we have no better alternative. Apatite has been reported in carbonaceous chondrites, but it is unclear that apatite abundances and actinide contents are sufficient to produce the Th/U correlations. Diluted merrilite is an unlikely low U component for carbonaceous chondrites. It may be better to regard this as a mixture of high Th/U CAI material with either inert material or a solar nebula component with solar actinide abundances. The required constant mixing ratios are perhaps surprising since chondrules constitute a significant actinide reservoir for unequilibrated chondrites, but perhaps these could be the required low U component.

There are testable predictions of the above interpretations: (1) relatively constant P contents in our ordinary chondrite samples regardless of Th/U; (2) Th/U <2 in ordinary chondrite apatite; (3) High actinide/P in leachable fractions of carbonaceous chondrites.

The solar Th/U ratio plays a major role in cosmochronology, but accurate knowledge is required. If Th/U variations in equilibrated ordinary chondrites are entirely due to relatively local actinide redistribution, controlled by Cl, then a more accurate solar system Th/U is obtained by averaging of high accuracy actinide analyses.