Using increment cores of eastern cottonwood trees (*Populus deltoides*) to assess the timing of Cd pollution

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We measured the concentrations of 8 trace metals in the trunk wood of ~40 eastern cottonwoods (*P. deltoides*), a fast-growing dioecious angiosperm common throughout much of eastern North America. Large trees were selected more or less at random from an area in northern Ohio (USA) that has a known history of soil pollution with a variety of metals and organic compounds, as well as from an equally sized control area. Two increment cores (L < 40 cm, ∅ 5 mm) were taken from each tree at chest level. To avoid contamination, annual growth rings were marked on one core and the markings were used to guide cutting of the sample core with tungsten carbide surgical tools into eight 5-year sections covering the period 1970–2009. The older and younger rings were not analyzed. All sections were completely microwave-digested (10 min at 200°C) in a mixture of 16 M nitric acid and 30% hydrogen peroxide, along with one blank and one pine wood SRM (NJV 94-5). The cooled digests were then weighed, diluted 100-fold, and analyzed by Octopole Reaction System ICP-MS (Agilent) for As, Cd, Co, Cr, Cu, Ni, Pb, and V.

While some metals (As, V) are always below the method detection limit (DL) and others appear to vary arbitrarily, Cd is the only one showing behavior that may be interpretable in terms of both space and time. Blanks were always below the DL (~15 ng Cd per g dry wood), there was no evidence of sample contamination, and analytical recovery of the SRM was excellent (>98%). The ~40 trees fall into three distinct groups: 1. Trees with low mean Cd concentrations (270 ng/g) and little temporal variability (n = 20); 2. Trees with a clear maximum or temporal trend in the Cd concentration of up to 1300 ng/g (n = 14); 3. Three trees with extremely high Cd concentrations (>2500 ng/g). Replicate cores taken from a single tree as well as from separate trees at a single location yielded satisfactory reproducibility (10–20%). Although the timing of maximum Cd concentrations varies, high amounts are not found in the most recent 10 years of any tree. All trees in group 3 and all but one tree in group 2 are located in the polluted area, whereas all but one tree in the control area are from group 1. A simple statistical test indicates that this distribution has an almost negligible probability of occurring by chance ($\chi^2 = 8.819$, $p = 0.003$).

Mg isotope evidence for ancient magmatic differentiation on the angrite parent body

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Angrite meteorites are the most alkali-depleted rocks in our solar system and they can be divided into plutonic and volcanic angrites [1]. Of the group of volcanic angrites, NWA 1670 is particularly interesting because it contains significant amounts of olivine xenocrysts of up to 5 mm in size that are chemically distinct from the groundmass [2,3]. The existence of xenocryst olivine not in chemical equilibrium with the groundmass offers the potential for a resolvable temporal difference between both phases. Therefore, considering the old age for this angrite [4], the xenocrysts may reflect an earlier magmatic event.

Here we apply the ^{26}Al to ^{26}Mg ($t_{1/2}$ = 0.7 Myr) chronometer to examine the temporal relationship of olivine xenocrysts and basaltic groundmass in NWA 1670. Mg isotope data for individual olivine grains and groundmass seperates were obtained using the Neptune MC-ICPMS. All olivine xenocrysts have negative μ^{26}Mg* with a mean of –10.7 ± 3.1 ppm. Measured μ^{26}Mg* of the groundmass ranges from –5.3 to +4.3 ppm and are positively correlated with ^{27}Al/^{24}Mg ratios. Both sets of data form an apparent isochron suggesting a similar ^{26}Al/^{27}Al abundance at time of their formation to that of other old angrites. However, the negative intercept of the isochron cannot be reconciled with the low ^{26}Al/^{27}Al abundance and suggests that the correlation is best explained as a two component mixing trend. Model ages for single xenocryst olivine range from 0.36 to 1.18 Myr after CAIs. A model age for the most anomalous groundmass sample yields an age of 3.9 Myr after CAIs, consistent with the Mg isochron ages for other volcanic angrites. These data demonstrate that olivine entrained in NWA 1670 are products of ancient magmatic differentiation on the angrite parent body shortly after solar system formation, which significantly predates the formation of volcanic angrites.

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DOI:10.1180/minmag.2013.077.5.19