Lead Isotope Age of Chondrules in the CR2 Chondrite NWA801 by a Progressive Stepwise Dissolution

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Summary

CR2 chondrites are a unique class of carbonaceous meteorites characterized by an abundance of metallic iron that forms multi-layered rims around silicate chondrules (Fig. 1). We have experimented with a progressive stepwise dissolution of chondrules from the CR2 chondrite NWA801 for the purpose of obtaining $^{207}Pb/^{206}Pb$ ages from the corresponding radiogenic leachates and residues. Following an extensive pre-cleaning to remove extraneous lead, three multi-chondrule fractions (12.6, 31.5 and 35.7 mg) were leached with acids of increasing strength starting from weak HCl and ending with HF/HNO_3. ID-TIMS analyses of the progressively stronger leachates (on a VG354 thermal ionization mass spectrometer in Daly and multi-dynamic-Faraday modes using a ^{235}U-^{205}Pb-spike) showed that both HF and HF/HNO_3 are efficient at extracting radiogenic Pb components from the chondrules ($^{206}Pb/^{204}Pb$ = 324 to 1114 after fractionation, blank and spike corrections). A weighted regression through the final three leaches and residues of each of the three multi-chondrule fractions (nine points total) yields a $^{207}Pb/^{206}Pb$ isochron age of 4564.6±1.0 Ma (95% confidence, MSWD=1.3) assuming that the lead is a mixture between blank and primordial Canyon Diablo Troilite Pb (CDT; Fig. 2). Our age for NWA801 chondrules is identical to the $^{207}Pb/^{206}Pb$ age of chondrules in the CR2 chondrite Acfer 059 (4564.7±0.6 Ma; Amelin et al. 2002) whereas chondrules from CB chondrites are ~2 Myr younger, and those from Allende (CV3) are at most ~2 Myr older (Fig. 3). This suggests that all chondrules in CR2 chondrites formed as a result of the same nebular event and may be from the same parent body. However the complex multi-rimmed textures of the chondrules in NWA801 (i.e. Fig. 1) suggest that multiple and as yet unresolved processes were involved during their formation.

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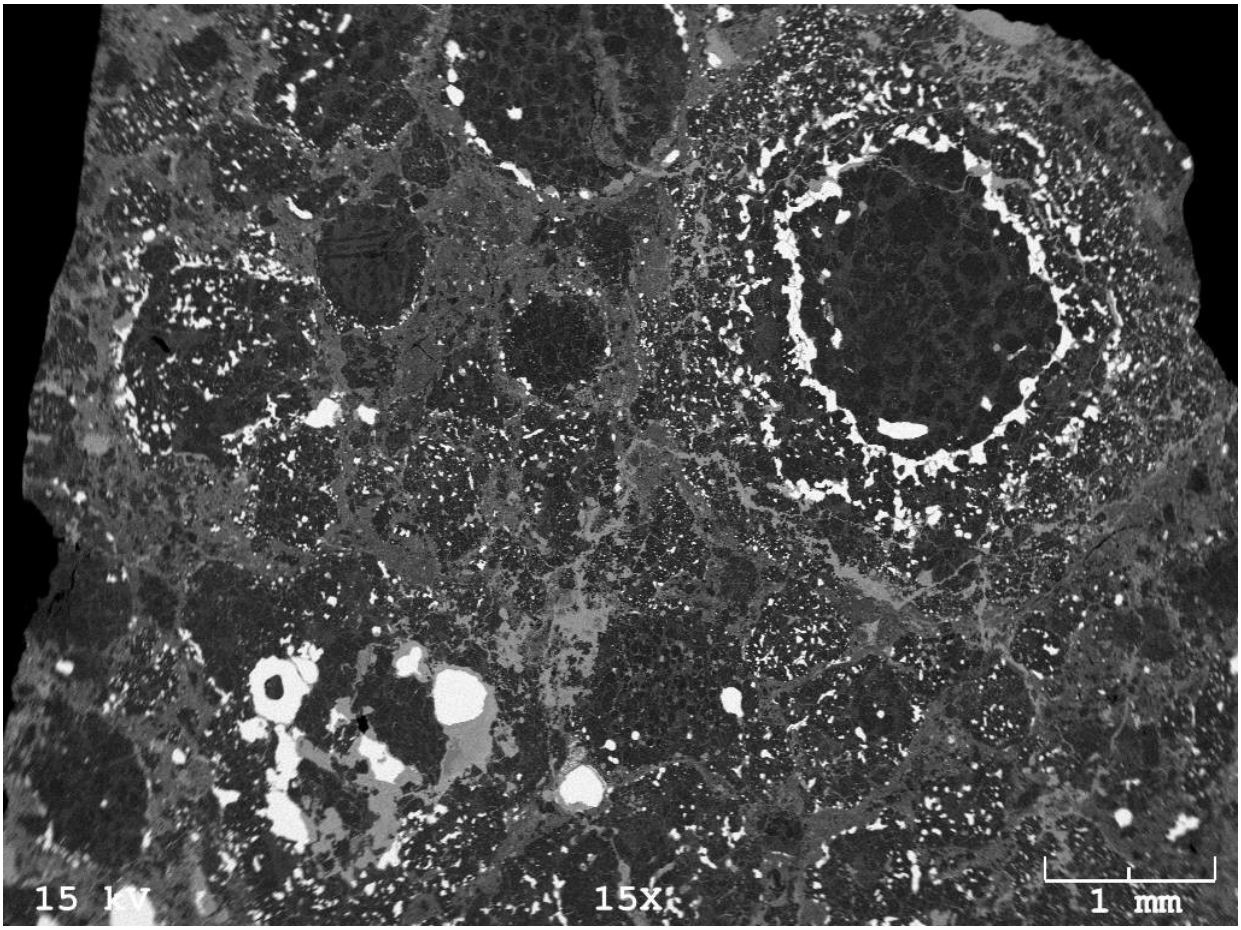

Figure 1: SEM-BSE image of chondrules in the CR2 chondrite NWA801. Bright regions consist of Fe-Ni. Darkest grains consist of olivine. Armoured ol-px chondrules are common, as well as complex multiply-rimmed armoured chondrules as shown.

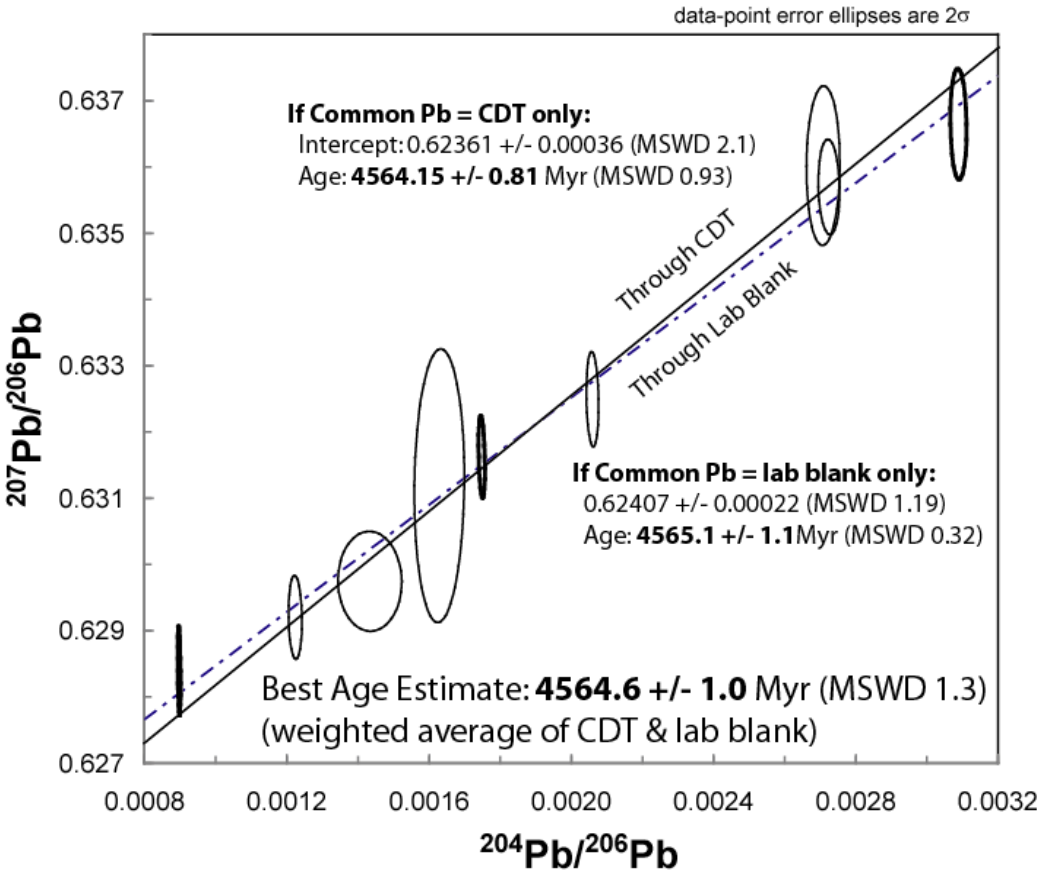

Figure 2: ID-TIMS results for the nine most radiogenic leaches and residues of NWA801 chondrules. Regressions are made using IsoPlot. Errors for all ages are at 95% confidence.

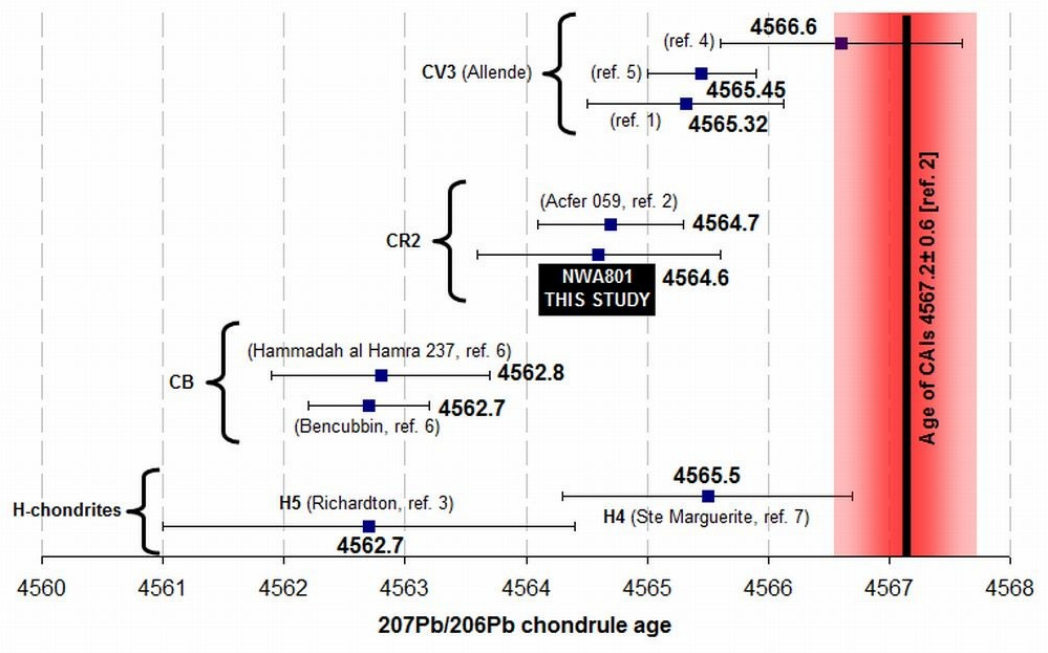

Figure 3: Comparison of some recent chondrule lead ages organized by descending age and grouped by meteorite type for a variety of carbonaceous chondrites and two H-chondrites. The age for CAIs is overlain; all errors are 2σ. References and meteorite names are shown.