overwhelms the solar contribution, an inference further supported by the fact that the highest $^{14}N/^{36}Ar$ ratios are observed among grains with the lowest ^{36}Ar amounts (Fig. 1).

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TRACE-ELEMENT ABUNDANCES AND THE ORIGIN OF ALUMINUM-26-BEARING CHONDRULES IN UNEQUILIBRATED ORDINARY CHONDRITES. G. R. Huss[1], G. J. Wasserburg[1], S. S. Russell[2], and G. J. MacPherson[2], [1]Division of Geological and Planetary Sciences, 170-25, California Institute of Technology, Pasadena CA 91125, USA (ghuss@gps.caltech.edu), [2]Department of Mineral Sciences, MRC NHB-119, National Museum of Natural History, Smithsonian Institution, Washington DC 20560, USA.

Calcium-aluminum-rich inclusions (CAIs) typically contain radiogenic ^{26}Mg ($^{26}Mg^*$) from the decay of ^{26}Al, with $(^{26}Al/^{27}Al)_i$ up to 5×10^{-5} [e.g., 1]. Some Al-rich chondrules from unequilibrated ordinary chondrites contain detectable $^{26}Mg^*$, but $(^{26}Al/^{27}Al)_i$ is lower [e.g., 2]. Ferromagnesian chondrules cannot currently be measured for ^{26}Al. Aluminum-rich chondrules have Al and Ca abundances that are intermediate between those of ferromagnesian chondrules and CAIs [1], but the relationships between these classes of objects is not clear. To clarify these relationships, we have determined major-, minor-, and trace-element abundances for seven Al-rich chondrules measured by [2], two of which apparently had $(^{26}Al/^{27}Al)_i \sim 9 \times 10^{-6}$.

Two Al-rich chondrules, Moorabie 6076-5-2 (M5-2) and Krymka 9-1 (K9-1), have bulk REE abundances near those of CI chondrites. They are porphyritic olivine chondrules with interstitial plagioclase. In both chondrules, LREEs are depleted by factors of 2.5–4 relative to HREEs and both show large positive Eu anomalies (6–8× CI). Calcium, Al, Sr, and Ba enrichments correlate with the Eu anomalies, suggesting that igneously fractionated plagioclase was a precursor for these chondrules. Iron is depleted in both chondrules, and alkalis are depleted in K9-1. These chondrules contained no evidence for ^{26}Al.

Four chondrules have bulk compositions that appear to be controlled largely by volatility. Chainpur 1251-14-1 (C14-1), Chainpur 1251-14-2 (14-2), and Chainpur 5674-2-1 (C2-1) contain large anorthite laths, while Chainpur 1251-3-1 (C3-1) is dominated by Na-rich glass. Refractory and moderately refractory lithophile elements are uniformly enriched at ~5× CI in C14-1 and 10–20× CI in C14-2, C2-1, and C3-1. Silicon, Mg, Fe, Rb, Na, and K are less enriched or depleted relative to CI composition. The REE patterns are essentially flat. Chondrules with REEs 10–20× CI have negative Eu anomalies ranging from ~30% in C2-1 to a factor of 30 in C3-1. These abundance patterns are broadly consistent with near-equilibrium evaporation of volatile elements from average nebular dust. However, abundances of depleted elements are not strictly consistent with expectations for evaporation, which suggests that the chondrules also contain a more-volatile-rich component. In addition to enrichments of refractory elements, C3-1 has large (~10× CI) enrichments of Na and Rb. A later process is clearly required to reintroduce these volatile elements. C3-1 contains evidence for ^{26}Al.

In Inman 5652-1-1 (I1-1), the other chondrule with evidence of ^{26}Al, refractory lithophiles are enriched 10–30× relative to CI, but moderately refractory lithophiles such as Ba and Sr are less enriched. LREEs are depleted relative to HREEs and there are pronounced negative Ce and Eu anomalies. These characteristics indicate more-extensive evaporation than that experienced by the other chondrules studied. Depletions of Ce, Eu, Ba, and Sr are inconsistent with equilibrium vaporization at a fixed f_{O_2}. However, similar depletions have been produced by evaporation in the laboratory [3,4]. An evaporating chondrule may change the effective f_{O_2} of its surroundings [e.g., 4]. Magnesium and Si are present in roughly CI abundances in this chondrule, again suggesting reintroduction of volatiles.

Our data indicate that two (at least) independent processes are involved in producing Al-rich chondrules. The compositions of M5-2 and K9-1 imply that igneous plagioclase was incorporated into an otherwise relatively unfractionated precursor. Chondrules I1-1, C14-1, C14-2, C2-1, and C3-1 have compositions consistent with evaporation as the main cause of refractory-element enrichment. Later reintroduction of volatiles is required for C3-1 and is likely for the others. Later addition of volatile elements may in part explain why the chondrules do not fall precisely on the evaporation trend in CMAS composition space [5]. However, none of the chondrules described here can be modeled by simple mixtures of CAIs and volatile-rich material of near-solar composition.

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RADIOGENIC CHROMIUM-53 IN CI CARBONATES: NEW EVIDENCE OF EARLY AQUEOUS ACTIVITY. I. D. Hutcheon[1], D. L. Phinney[1], and R. Hutchison[2], [1]Isotope Sciences Division, Lawrence Livermore National Laboratory, Livermore CA 94551, USA, [2]Department of Mineralogy, Natural History Museum, London SW7 5BD, UK.

Excesses of radiogenic ^{53}Cr, produced by the *in situ* decay of ^{53}Mn ($\tau_{1/2}$ ~3.7 Ma), in carbonates in the CI chondrites Orgueil and Ivuna provide evidence for the very early onset of aqueous activity on the CI parent body, within ~15 Ma of the crystallization of Allende CAIs [1,2]. While generally correlated with Mn/Cr, the $^{53}Cr^*$ excesses do not define a single line on a ^{53}Mn-^{53}Cr evolution diagram, leading to suggestions that aqueous alteration was episodic, extending over a period of several million years. As part of an ongoing study of the timescales of nebular and parent-body metamorphic processes, we investigated the Cr isotopic composition of a new suite of Orgueil carbonates and carbonates in a CI clast in the Supuhee (H6) chondrite. The Orgueil carbonates are isolated grains similar to those studied previously [2] and were selected for their relatively high Cr contents, Mn/Cr <2500. The Supuhee CI clast is roughly triangular in shape, ~0.5 mm across, and consists of abundant framboidal magnetite, euhedral to subhedral plates and laths of troilite, Mn-rich, carbonates and minor Ca phosphate set in a very fine-grained matrix. The clast is similar in appearance to Supuhee Clast 1 [3], although sulfide and magnetite are much more abundant, constituting ~50% of the mode, and making the clast readily visible to the naked eye. The boundary between the clast and the host chondrite is abrupt, with no evidence of intermingling. The carbonates are generally rounded, ranging in size from <15 to 80 mm, and are cross-cut by matrix-filled fractures; mafic inclusions are absent. Compositionally, the carbonates are very similar to dolomites found in Orgueil [4], containing up to ~18% $MnCO_3$. No evidence of the pronounced chemical zonation seen in Orgueil carbonates [2] was observed.

All five Orgueil carbonates exhibit enrichments in ^{53}Cr with $\delta^{53}Cr$ values between ~10 and 80‰. In four of the five, $\delta^{53}Cr$ is linearly correlated with the respective Mn/Cr and the data lie within 2σ of a correlation line with slope corresponding to $(^{53}Mn/^{55}Mn)_0 = 3.4 \times 10^{-6}$; data from the fifth carbonate lie ~ 4σ above this line. Four of five carbonates from the Supuhee clast also show clearly resolved ^{53}Cr excesses, albeit with substantially larger uncertainties in $\delta^{53}Cr$ ($2\sigma \sim 30$‰). High-spatial-resolution SIMS techniques (with concomitantly lower ion intensities) were required to avoid Cr-rich CI matrix-filling fractures in the carbonates. The $\delta^{53}Cr$ values in Supuhee range up to ~70‰ and are correlated with the respective Mn/Cr within analytical uncertainty. Most of the Supuhee data lie above the Orgueil correlation line; a line fitted to the Supuhee carbonate data has a slope corresponding to $(^{53}Mn/^{55}Mn)_0 = (8 \pm 4) \times 10^{-6}$.

Orgueil carbonates with a high Cr content define a ^{53}Mn-^{53}Cr correlation line with slope nearly twice that of the line fitted to all Orgueil carbonate data [2]. It is implausible that the formation of high- and low-Cr carbonates was separated by ~3 m.y. and this difference in slope suggests Cr was mobile during aqueous alteration, with preferential loss of radiogenic $^{53}Cr^*$ from some carbonates. The evidence of $^{53}Cr^*$ in the Supuhee clast sug-