THERMAL HISTORIES OF CO3 CHONDRITES: CONSTRAINTS ON PARENT BODY SIZE AND TIME OF ACCRETION.

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Introduction: CO3 chondrites were metamorphosed but little affected by impacts: almost all are unshocked (14 of 15 are S1) and virtually unbrecciated [1, 2]. Comparisons with type 3 ordinary chondrites suggest they can be assigned to subtypes 3.0-3.7 [1, 3]. Peak temperatures are estimated to be around 400-500 °C [4], but the duration of metamorphism and the size of the parent body are not well constrained. Estimates of parent body size would help greatly in the identification of their parent asteroid [3].

Moynier et al. [5] argued that the parent bodies of the carbonaceous chondrites were ≤20 km in size. They inferred from their Mn-Cr data that the parent bodies of carbonaceous chondrites accreted <1.2 Myr after CAI formation. Recognizing that such bodies would be melted by ^{26}Al if they lost heat on timescales that were longer than the ^{26}Al half-life, they argued for small bodies. However, Al-Mg ages of CO3 chondrite chondrules are 2-3 Myr after CAI formation [6]. If ^{26}Al was homogeneously distributed, accretion at 2.7 Myr would ensure peak temperatures of ~600°C in bodies that were >20 km across [7].

Methods: We studied metallic Fe,Ni grains in thin sections of three CO3 chondrites using techniques applied to H3-6 chondrites [8]. Suitable kamacite and taenite grains were located using X-ray scanning images. Ni zoning profiles were measured from kamacite to the center of adjacent taenite grains to confirm that taenite grains had M-shaped Ni profiles. Some taenites were rejected because of inclusions or grain boundaries. Metallographic cooling rates at ~500°C were determined from central Ni concentrations of taenite and the apparent distance to the nearest edge. 12-18 equant taenite grains about 10-40 μm across were analyzed in each chondrite.

Results: Cooling rates for the CO3 chondrites are as follows:

	Subtype	Cooling rate (°C/Myr)	Lowest Ni conc. (wt.%)
ALH 85003	3.5	2	35
Felix	3.3-3.6	3	36
Warrenton	3.7	5	32

Discussion: Our data show that all three CO3 chondrites cooled at a few degrees per Myr, consistent with [9]. Lower limits to peak temperatures inferred from the lowest Ni values in taenite are 500°C for Warrenton and ~50°C lower for the other two chondrites. Most other type 3s with metallographic cooling rates cooled at 2-20°C/Myr [8]. We infer that ^{26}Al was the major heat source for heating CO3 chondrites, consistent with the chondrule ages, and that impact heating was not significant. H chondrite thermal models suggest that the radius of the CO3 body was at least ~50 km.

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