IS THE (20) MASSALIA FAMILY THE SOURCE OF THE L-CHONDRITES?

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The L-chondrites are the most common meteorite type currently falling to Earth and have been one of the two most abundant types for the past million years or more.

Approximately 470 Myr ago the sole (or primary) parent body of the L-chondrites suffered a catastrophic collision, an event recorded in the ^{40}K-^{40}Ar shock ages of a large fraction of the L-chondrites. The event generated a large amount of debris in the inner solar system indicated by the ~100 fold increase in fossil L-chondrite meteorites in geological deposits of Middle and Late Ordovician age. It is commonly believed that this impact shattered the L-chondrite parent body forming an asteroid family.

Identification of the source family of the L-chondrites would provide a nebular location for the conditions and processes recorded in these chondrites. Additionally such a link would provide a firm calibration for dynamical models of asteroid orbital evolution.

Using reasonable assumptions, theoretical modeling of asteroid family ages pointed to the Gefion family as a likely candidate for the source of the L-chondrites. It is expected that such a family would be comprised largely of L-chondrite lithologies. This conclusion has been tested observationally with the result that most of the Gefion family objects investigated do not exhibit L-chondrite compositions.

An L-chondrite source family should exhibit several characteristicsm including:

A) The family should be located close to a resonance escape hatch in the asteroid belt.

B) The family should be primarily S-type objects.

C) L-chondrite lithhologies should be common within the family.

D) The family should be located at a low inclination.

We suggest that the Massalia family meets these criteria and have undertaken an observational program to test the family as the potential source of the L-chondrites. Unlike other potential low inclination families located near a resonance, the limited available Massalia family S-asteroids spectra indicate L-chondrite lithologies.

Meteorites provide detailed chronological information on the conditions and processes in the late solar nebula and the early solar system. However, the spatial locations of the conditions and processes recorded by the meteorites is poorly constrained except for a few examples where probable parent bodies have been identified (e.g. 4 Vesta and the HED meteorites, 6 Hebe and the H-chondrites, 3103 Eger and aubrites).

Approximately 135 chemically and isotopically distinct parent bodies are represented in our meteorite collections. This implies that the solar nebula was subdivided into a plethora of compositionally distinct regions instead of a smoothly varying radially monotonic disk.

Since the larger asteroids tend to still reside close to their initial relative heliocentric formation distances, identification of the asteroidal parent bodies of specific meteorite types allows us to map out the relative heliocentric pattern of annuli in the nebula and constrain the frequency of azimuthally discrete regions within the annuli.

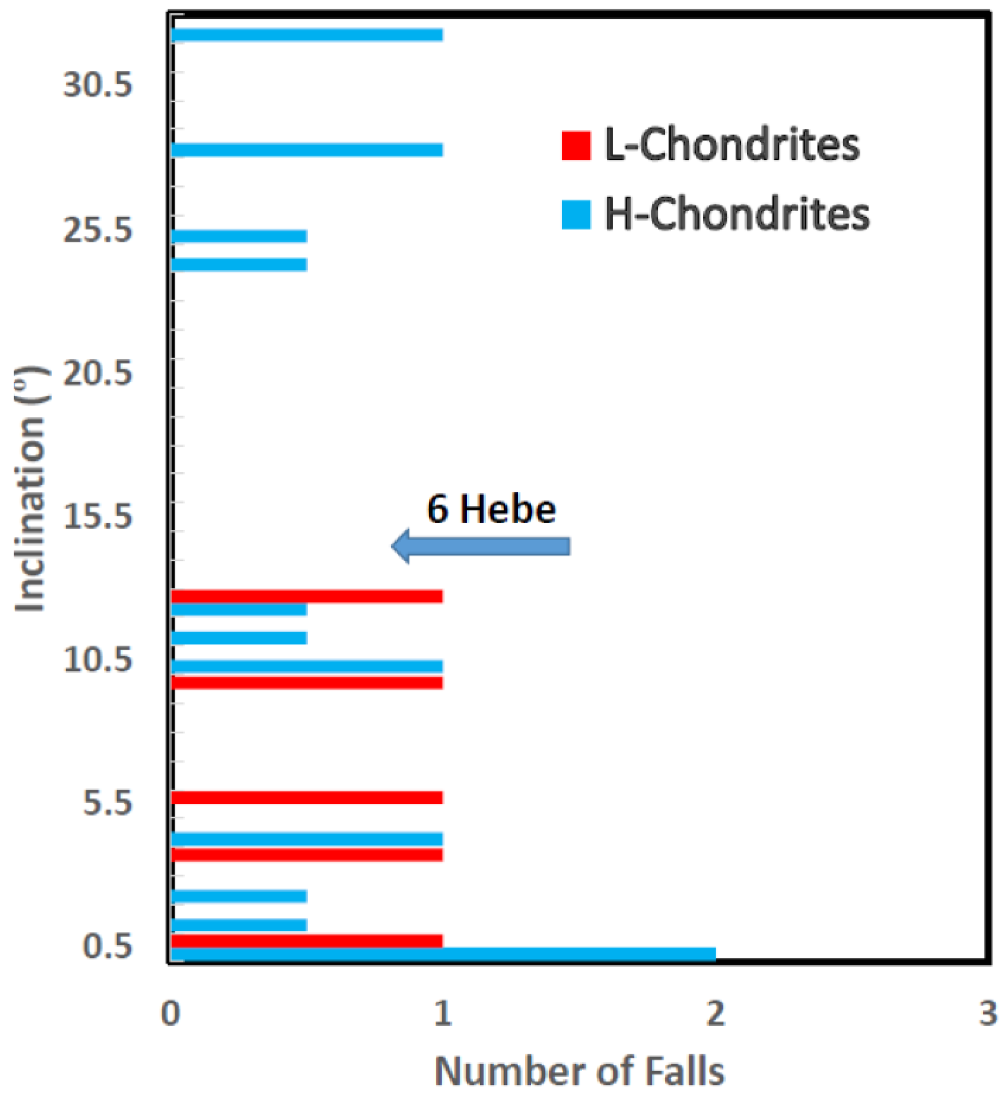

Figure 1 – Orbital inclinations of meteoroids producing H- and L-chondrite falls. The H-meteoroids scatter around the inclination of asteroid (6) Hebe, the probable H-parent body. The L-meteoroids show a similar scatter but centered near an inclination of 0º suggesting a low inclination source.

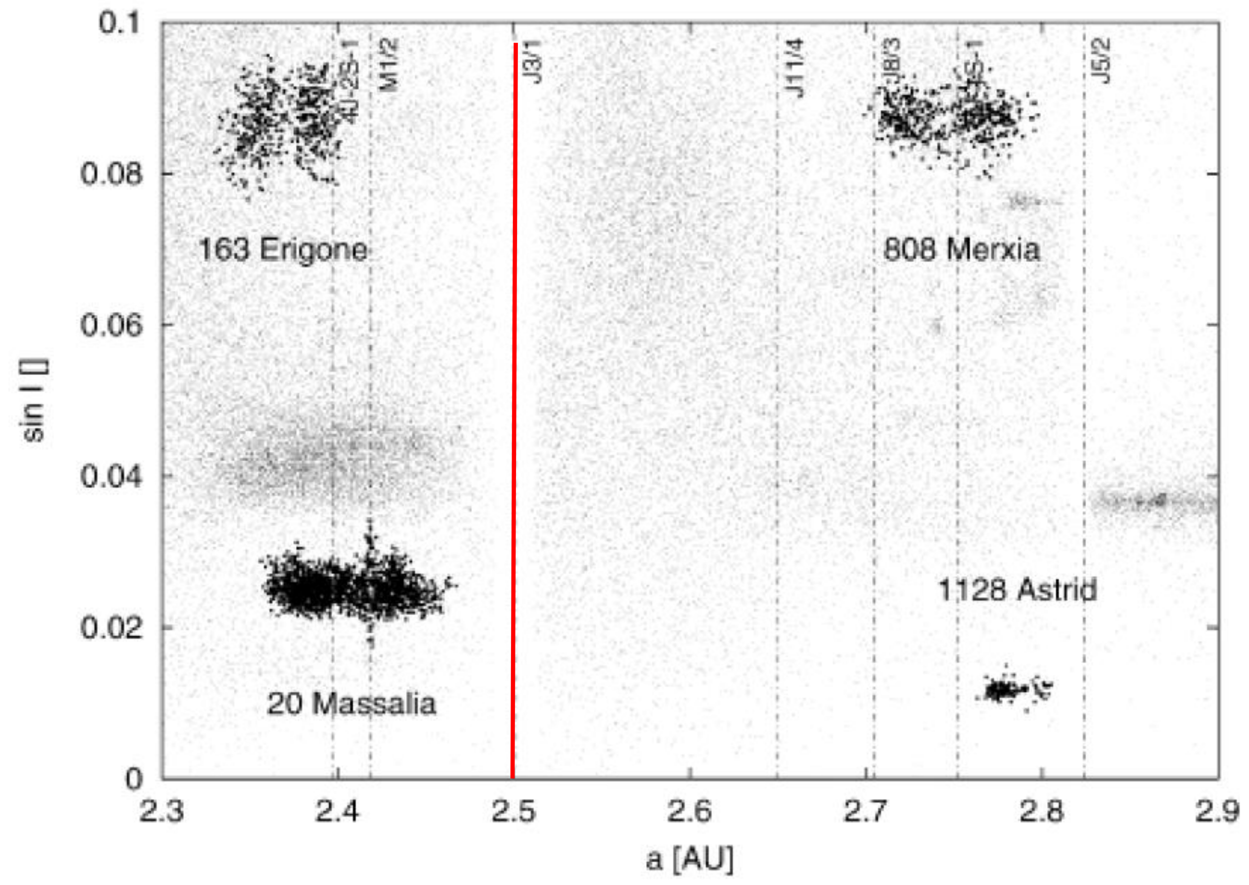

Figure 2 – Location of the 20 Massalia dynamical family in proper Sine Inclination versus proper semi-major axis (a) from Vokrouhlický *et al*. (2006). The 3:1 mean motion resonance with Jupiter is indicated by the red line at 2.5 AU. The average inclination of the Massalia family members is ~1.5º.

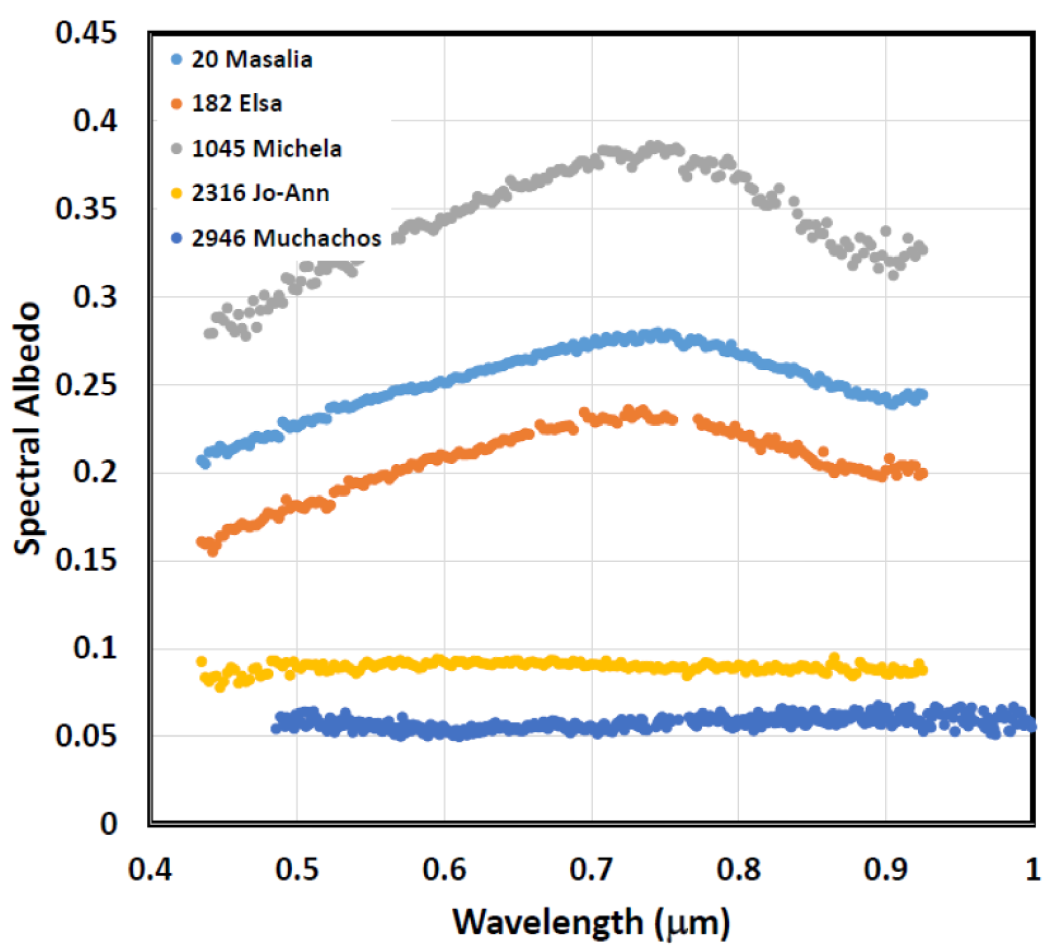

Figure 3 – CCD spectra of five Massalia family members. Data from SMASS (Bus and Binzel 2002). Normalized reflectances have been multiplied by the NEOWISE albedos. The lower two spectra 2316 Jo-Ann and 2946 Muchachos are considered as interlopers in the family.

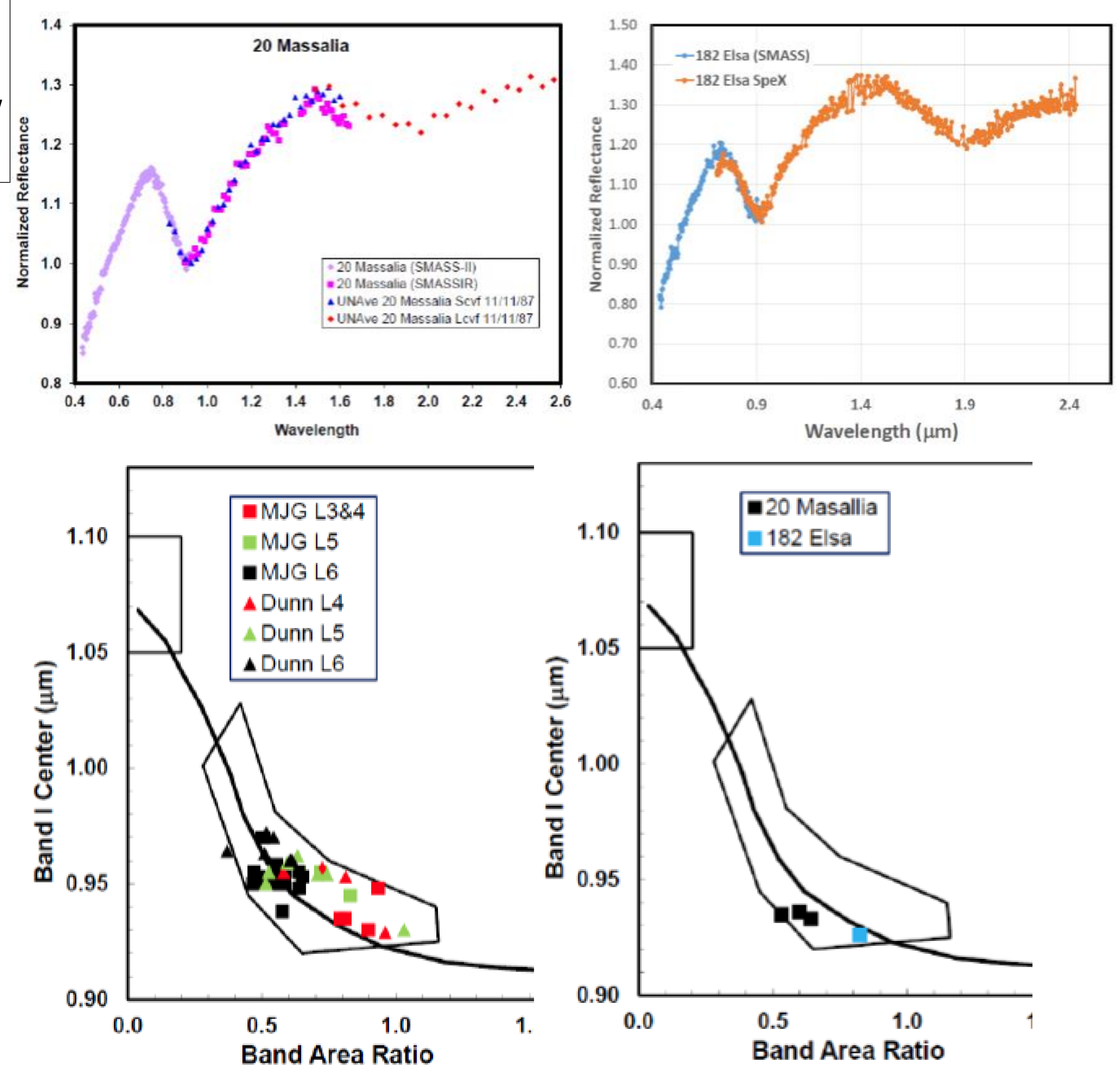

Figure 4 – Top: VNIR spectra of two S-type Massalia Family members (asteroids 20 & 182). Bottom: S(IV) region of Band I versus Band Area Ratio plot showing (left) distribution of parameters for L-chondrites, and (right) parameters for asteroids 20 and 182.