Testing the Gefion family as a possible parent body for the L-chondrite meteorites.

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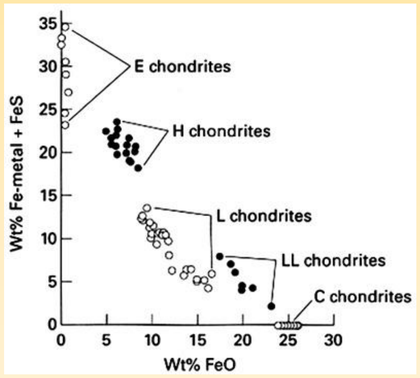
Introduction

At around 80%, the ordinary chondrites are the most abundant types of meteorites falling to Earth [1-3], and based on Antarctic meteorite collections, this prevalence has been maintained for at least the past million years [4].

The ordinary chondrites are subdivided into three groups based on the ratio of metallic iron to oxidized iron as seen to the right. L-chondrites fall in the middle.

Linking L-chondrite meteorites to an asteroid, or asteroid family, will make it possible to pinpoint particular isotopic and mineralogical compositions to a specific location within the asteroid belt, allowing for a more robust understanding of thermal and compositional gradients present in the solar nebula [5].



From: www4.nau.edu

Metallic iron vs. oxidized iron graph separating the ordinary chondrites into three groups; H,L,and LL.

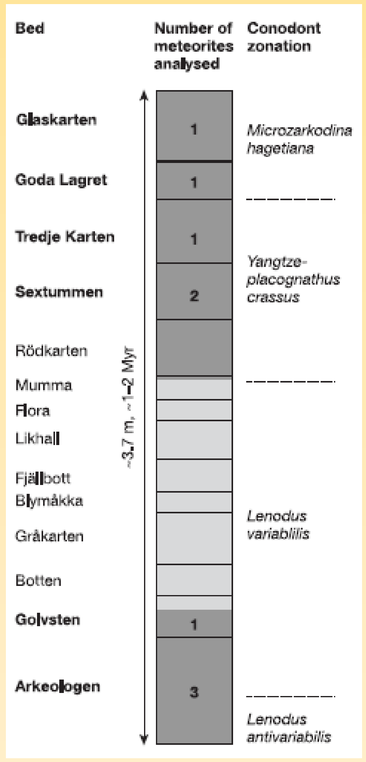
Background

Over the past 20 years or so, fossil L-chondrite meteorites have been found in relative abundance within Ordovician-era Swedish limestone quarries [6].

The time interval of limestone strata is dated by marine fossils at about 2 Myr, with an overall age of 467.3±1.6 Myr [7].

L-chondrite material throughout the strata interval infers an increase in meteorite flux over the present day by two orders of magnitude, continuing for 1-2 Myr [6].

The overall age coincides nicely with the ^{40}Ar-^{39}Ar determined age of the L-chondrite break-up event of 470±6 Myr [8].



From: Heck et al., (2004)

Limestone strata of the Thorsberg Quarry in Southern Sweden, with concomitant marine fossil zones.

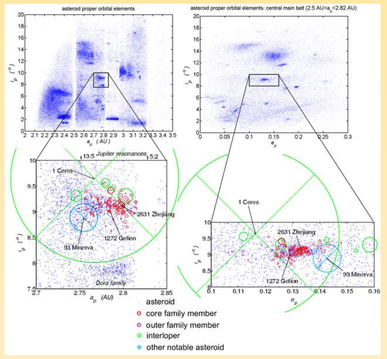
In addition, cosmic ray noble gas measurements support transfer times as short as 100,000 years for L-chondrite meteorites to reach Earth, with ages increasing with stratigraphic height [9].

This reinforces evidence of a continuous flux of meteorites to Earth following a parent body break-up event, and also reveals that there is a strong resonance in the main asteroid belt delivering the fragments to Earth.

Hypothesis

Recently, based on orbital dynamical modeling, it has been hypothesized that the Gefion family may be the parent body for the L-chondrite meteorites [10].

It is situated very close to the 5:2 resonance with Jupiter (to the right), and the modeled impact rate of meteorites from that resonance are agreeable with the



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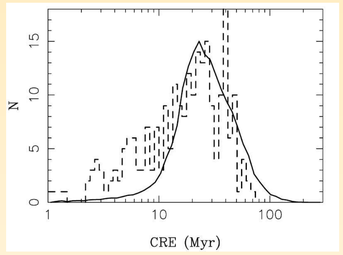


From: Nesvorný et al., (2009)

The step-like structure represents measured CRE ages of L-chondrites, the peaked line represents the modeled values.

The position of the Gefion family within the main asteroid belt, and very near to the 5:2 resonance with Jupiter.

cosmic ray exposure age range of recent L-chondrite meteorites (at left).

The next step then, is to test the hypothesis.

How do we test?

An unequivocal determination of a genetic relationship between the L-chondrite meteorites and the Gefion family will most likely require a sample return mission. However, the family can be classified as a probable or plausible parent body based on two main criteria [5].

Plausible parent body

Has compatible surface mineralogy with L-chondrites, or has favorable orbital location to yield meteoroids to Earth.

Probable parent body

Meets both criteria.

The Gefion family is well positioned with regards to orbital location, placed next to the 5:2 resonance, so the specification of its surface mineralogy is what this ongoing research strives to ascertain.

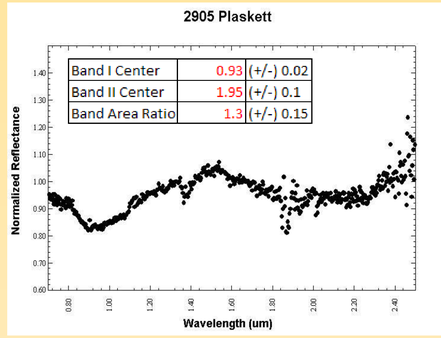
Asteroid Spectroscopy

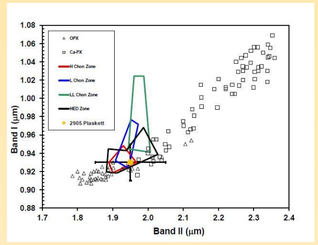
Gefion family asteroids were observed using the SpeX instrument at the NASA Infrared Telescope Facility (IRTF) on Mauna Kea, Hawai'i. Spectra of 2905 Plaskett were taken on June 4, 2011 under less than ideal weather conditions. 3910 Liszt was observed on July 18, 2011 under much better weather conditions.

Results

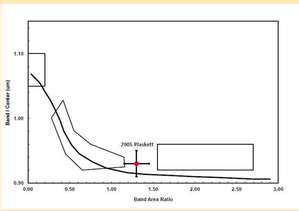
The mineralogy of the reflectance spectra obtained for the two Gefion family asteroids is interpreted through band position, and band area ratio as measured below.

2905 Plaskett has a bit of uncertainty due to poor seeing, but its band parameters suggest it is reconcilable with an L-chondrite.

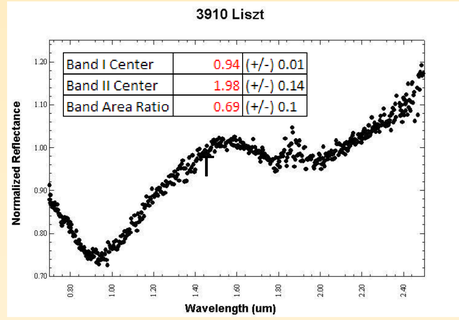




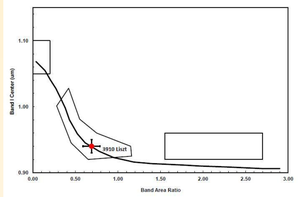
The Band I center vs. Band II center plot places 2905 Plaskett within the area for H- and L- chondrites on the opx/cpx trendline.



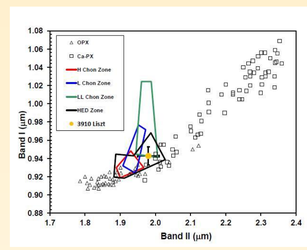
The Band I center vs. the Band Area Ratio plot places 2905 Plaskett just outside of the ordinary chondrite zone (boot-shaped area)



3910 Liszt is a better spectra, and in terms of bulk parameters could be an L-chondrite, although its also leans toward an LL-chondrite.



The Band I center vs. Band Area Ratio plot places 3910 Liszt in a nice L-chondrite position within the ordinary chondrite zone.



The Band I center vs. Band II center plot places 3910 Liszt closer to the LL-chondrite zone, but within limits of the L-chondrites.

Conclusions

Although the mineralogy as interpreted by band parameters does not unambiguously place these asteroids as L-chondrites, both are within bulk parameters for that definition. **Therefore, the hypothesis that the Gefion family may be the parent body for the L-chondrite meteorites is still viable.**

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Acknowledgements

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