Do the L chondrite meteorites really come from the Gefion Asteroid Family?

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Introduction: The Gefion Asteroid Family (GAF) is located between 2.71-2.82 astronomical units (au) in the outer Main Asteroid Belt [1, 2], which has been dynamically defined, and is also proposed to be the source for some ordinary chondrite meteorites [3, 4]. A fraction of the 2,547 members of the GAF appear to be related within the S-complex type of asteroids [5, 6], which are dominated by the mafic silicate minerals olivine and pyroxene [7]. Previous work has shown compositional affinities to multiple meteorite types for members of the GAF [8-12]. A test for compositional relatedness to a specific meteorite type of this dynamically-defined asteroid family is used to create a stronger linkage amogst the members by using surficial amoutns of olivine and pyroxene minerals.

The most common type of meteorites that arrive to Earth are the ordinary chondrite (OC) meteorites (86%, The Meteoritical Bulletin). These meteorites are dominated by ~millimeter-sized chondrules comprised of olivine and pyroxene minerals. The OCs are subdivided by their iron content: H chondrites (26-31%), L chondrites (20-25%), and LL chondrites (19-22%). The L chondrites have been proposed to be derived from the GAF [3, 4]. Interestingly, members from the GAF have shown to have compositional affinities to both L chondrites as well as H chondrites [8-12]. Furthermore, work done by [13, 14] suggests geochemical evidence in the terrestrial meteorite collection for an order of ~100 parent bodies, with ~20 of those belonging to ordinary chondrite sources. Subsequently, a larger effort for observational campaigns of asteroids, and their associated families, proves useful towards creating linkages.

Compositional Analysis: Six GAF members were observed in the near-infrared (~0.7-2.5 μm) using the NASA Infrared Telescope Facility (IRTF) using the SpeX instrument [15, 16]. The asteroid compositions were measured with protocols described in [12] for the olivine mineral fayalite (Fa) and the pyroxene mineral ferrosilite (Fs). Overall, their composition is consistent with S-type asteroid spectral features, which are described by spectral absorption bands due to the presence of the mafic minerals olivine (Fe-end member, Fayalite, Fa) and pyroxene (Fe-end member, Ferrosilite, Fs) [7]. The measured spectral feature near ~1 micron is denoted Band I Center (BIC) and arises from transition metals absorbing near ~1 μm relative to Fa and Fs combined make this feature. The band center represents the position of this continuum-removed absorption feature. The molar amount of each respective mineral is derived using methods from [17] by means of the BIC and compared to laboratorial spectral data for OC meteorites [18]. Measured BIC and molar Fa and Fs values are reported in Table 1. Fs and Fa molar values are shown in Figure 1 and Table 1.

Results: The Fa and Fs content for the six observed asteroids show that they primarily span the L and LL chondrite types rather than the H chondrite. This is in contradiction to the original proposed hypotheses that GAF is the source of purely that of the L chondrites [3, 4]. However, this adds to the previous work showing a span of meteorite affities between H- and L chondrites [8-12].

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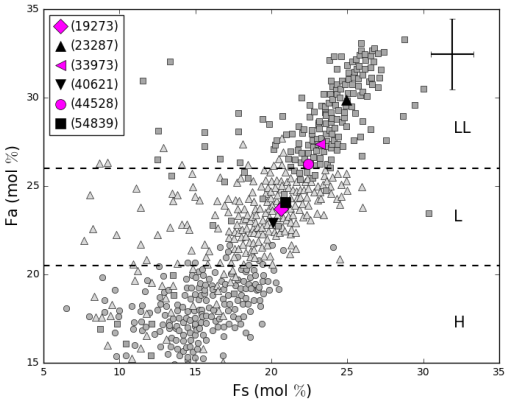
Figure 1: Six GAFs observed showing Fa and Fs. **Table 1**: Band I Center (BIC) and OC compositions.



Target	D (km)	B1C	Fa (%)	Fs (%)
19273	3.89	0.943± 0.01	20.6± 2.0	23.7±1.4
23287	3.99	0.992±0.013	24.9± 2.0	29.9±1.4
33973	4.0	0.966±0.001	23.1± 2.0	27.4±1.4
40621	3.04	0.939±0.005	20.1± 2.0	22.3±1.4
44528	4.67	0.958±0.004	22.4± 2.0	26.2±1.4
54839	5.08	0.945±0.004	20.9± 2.0	24.1±1.4

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