Chemical and physical properties of comets in the Lowell database: Results from 35 years of narrow-band photometry

D. Schleicher[1] and A. Bair[1]

[1]Lowell Observatory

As remnants from the epoch of early solar-system formation, comet nuclei are less processed than any other class of objects currently available for detailed study. Consequently, differences in the chemical composition among comets can indicate either differences in protoplanetary material and primordial conditions in our solar system or subsequent evolutionary effects. By gathering chemical and physical data on a large sample of comets and correlating these with dynamical properties, we can perform statistical analyses to determine the actual cause of a specific difference in properties. We have recently completed a new uniform reduction and set of analyses of the Lowell comet database, which includes 35 years of narrowband photometry of 167 comets. To minimize uncertainties due to too few data points or other systematics, a restricted subset of the database was created for chemical compositional studies, and mean abundance ratios were computed for each of these 101 comets. We used a variety of taxonomic techniques to identify seven compositional classes and to determine the membership of each class. Several classes are simply sub-groups of the original carbon-chain depleted class as defined by A'Hearn et al. (1995); all evidence continues to indicate that carbon-chain depletion reflects the primordial composition at the time and location of cometary accretion and is not associated with evolution. Among the other new classes is one containing five comets that are depleted in ammonia but are not depleted in carbon-chain molecules, but it is unclear if this compositional class is primordial or not.

Other, non-compositional analyses were performed, using appropriate sub-sets of the entire database for each investigation. These included active areas, active fractions, and the behavior of the dust-to-gas ratio. Regarding the dust-to-gas ratio, we observed trends with respect to both perihelion distance and to age, implying an evolution of the surface of the nucleus associated with the peak temperature attained and how often it has been reached. Details of these and other results will be presented.

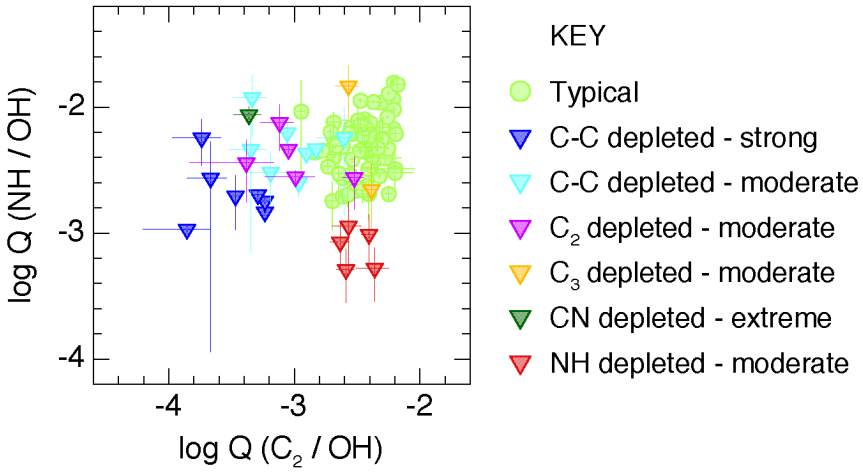

Figure: One of numerous plots used to determine the taxonomic classifications.

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References: A'Hearn, M. F., Millis, R. L., Schleicher, D. G., Osip, D. J., and Birch, P. V. (1995) Icarus 118, 223–270.