**ELEMENTAL COMPOSITION OF COMETS: A MASS BALANCE MODEL.**

L. J. Spivak-Birndorf and M. Yu. Zolotov. School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287-1404. E-mail: Lev.Spivak-Birndorf@asu.edu.

**Introduction:** Investigations of comets demonstrate that their nuclei consist of undifferentiated mixture of volatiles (ices), refractory carbonaceous compounds and mineral grains, which could have originated in hot nebular environments [1-4].

One approach used to estimate the elemental composition of comet nuclei has been to evaluate observational data using certain assumptions about that nature of comets [e.g., 1]. Here we present a mass balance evaluation for an idealized comet nucleus using a three-component (rocky + volatiles + refractory carbonaceous material) model as well as recent remote sensing and sample return data on comets [2-4,6].

**Constructing an Idealized Comet:** In this model we assume that comets contain the relative solar photosphere abundances of elements [5], except H and N. The abundance of H in the model nucleus is determined by the abundance of H-bearing compounds and can vary slightly, and N is 2-3 times below solar values [6] due to the likely incomplete condensation of $N_2$. These elements are divided between the three major components of the comet nucleus listed above in proportions that are constrained by analytical data on the composition of cometary materials [2,3] and remote sensing data on cometary volatiles [4].

We use the mineralogy of samples returned by Stardust [2] as a guide to constrain the composition of the rocky component in this model comet. The Na, Mg, Al, Si, K, Ca, Cr and Mn are assumed to exist as oxides in silicate minerals. Sulfur and P are assumed to be in solid FeS and $Fe_3P$, while the remaining Fe, Ni and Co are assumed to be metal.

The remaining portion of O left after designating the rocky component is split between the volatiles and refractory carbonaceous material, along with the C, N and H. In the model, the abundances, relative to water, of some of the major volatiles in comets are constrained by the averages of values measured in some well-characterized comets [4]. The estimated $H_2O$-free volatile component of these comets has C:H:O:N ≈ 100:143:91:6. Although absolute water content of these comets is not known, the ratio of O in the water ice relative to other volatiles is fixed at ~9 in the model based on observational data [4].

The remainder of the O, C and N not occurring as volatiles are assigned to the refractory carbonaceous component. At this point, adjusting the absolute water ice contents of the model comet results in variations of the C/O and C/N atomic ratios of the refractory carbonaceous component. The most pristine sample of this carbonaceous material could be present in anhydrous IDPs, where it has ratios of C/O ≈ 2 and C/N ≈ 10 [3]. Adjusting the water contents in this model comet until the C/O ratio of the refractory component is ~2 results in a C/N ≈ 7-12, which is consistent with measurements of this material in anhydrous IDPs [3].

This model tightly constrains the composition of an idealized comet nucleus, providing estimates of absolute water ice content (~24 wt. %) and the dust/gas ratio (~1.3), which is consistent with independent evaluations [e.g., 7].

**References:** [1] Greenberg J. M. 1998. *Astron. Astrophys.* 330, 375-380. [2] Zolensky M. E. et al. 2006. *Science* 314, 1735-1739. [3] Cody G. D. et al. 2008. *M&PS* 43, 353-365. [4] Bockelée-Morvan D. et al. 2004. Comets II, pp. 391-423. [5] Asplund M. et al. 2005. *ASP Conference Series* 336, 25-38. [6] Jessberger E. K. and Kissel J. 1991. In: Comets in the Post-Halley Era, V2., pp. 1075-1092. [7] Lisse C. et al. 2006. *Science* 313, 635-640.