RELATIONSHIP OF C-TYPE ASTEROIDS TO DARK METEORITES : EVIDENCE FOR OPTICAL ALTERATION BY ASTEROIDAL REGOLITH PROCESSES. D.T. Britt, C.M. Pieters, R.S. Webb, and S.F. Pratt, Box 1846, Brown University, Providence, RI 02912.

Introduction: Dark asteroids (IRAS albedos < 0.15 [1]) dominate the population of main belt asteroids, accounting for an estimated 70% of objects [2]. The dark carbonaceous chondrite meteorites are the most common meteorite compositional analog based on spectral characteristics suggested for these asteroids [3,4]. However, there are other dark meteoritic materials such as the ureilites, black chondrites and the gas-rich portions of the gas-rich ordinary chondrites that also have spectral characteristics similar to the carbonaceous chondrites [5]. Britt and Pieters have shown that the spectral properties of some optically-altered black chondrites are similar to those of some dark asteroids of the inner-belt C, G, F, B types [6,7]. In addition, they proposed that some regolith processes appear to have the effect of darkening and flattening the spectral characteristics of the surface material. If such an alteration process is dominant on ordinary chondrite parent bodies, then their optical properties would appear similar to the dark C-type asteroids. To further examine the relation between dark asteroids and their potential meteorite analogues, the spectral characteristics of an expanded set of carbonaceous chondrite and black chondrite meteorites are examined with a set of asteroid spectra. All dark asteroid spectra used in this analysis were of objects with diameters greater than 100 kilometers and orbital semi-major axis less than 3.0 astronomical units. This data set samples objects that should be able to retain a significant regolith [8] and that are within the compositional and dynamical zones thought to supply ordinary chondrite meteorites [4,9].

Analysis of Asteroid and Meteorite Spectra: Direct comparisons between spectral data sets can be made using the statistical technique of principal components analysis. This technique quantifies the variance in a data set and reprojects the data into an arbitrary space defined by a system of orthogonal principal components. Distance in this space is a measure of relative similarity [10]. In applications to spectral data sets, principal components analysis can be used to make consistent comparisons of relative similarities of major spectral features such as continuum slope and the one micron absorption band. Principal components analysis was used to quantify the general spectral similarities of a data set consisting of 53 C-type asteroids (Tholen's C, B, G, and F-types) [11,12], 13 carbonaceous chondrite meteorites [5], and 9 optically altered black chondrite meteorites [5,13]. The asteroid data were based on the 8-color asteroid survey system of Zellner et al. [13]. Meteorite spectra were obtained for unweathered particulate samples. The meteorite spectra were converted into the 8-color system using digital 8-color band passes to resample the high-spectral resolution laboratory spectra into the 8-color system. The asteroid and meteorite samples were selected to cover a similar albedo range and albedo was removed from the analysis by scaling the spectra to unity at 0.55 microns.

Discussion: Shown in **Figure 1** are the first two principal components of the combined asteroid and meteorite data sets. For the asteroids, the PCA analysis was successful in distinguishing the spectral sub-classes of the C-type asteroids and separating them into distinct areas of principal component space. The most striking result, however, is the relative positions of the carbonaceous and black chondrite groups. The carbonaceous chondrites, the most common compositional analog based on spectra for the C-type asteroids, do not plot close to the field of C-types. In contrast, many of the optically altered black chondrites plot close to or within the field of C-type asteroids, indicating a greater overall similarity between the major spectral characteristics of some black chondrites and some C-type asteroids. These results suggest that: (1) If the dark asteroids and dark meteorites are gentically related, then regolith processes on small bodies are most likely responsible for these diferences in their optical properties. Although this analysis does not directly link any class of meteorite with any asteroid type, their distinct differences do show that it is important to study optical alteration in meteorites in order to understand the effects of regolith processes and to interpret remotely obtained spectra. (2) From the grouping and relative positions of the different types of meteorite and asteroid spectra in principal component space, it is apparent that if an asteroid is dark it does not automatically follow

that it is carbonaceous in composition. (3) If the type of alteration exhibited by black chondrites is common, some of the C-type asteroids could be possible parent bodies for the most severely optically altered ordinary chondrites.

References: [1] *IRAS Asteroid and Comet Survey: Preprint Version #1 (1986).* (D. Matson, ed.) JPL Internal Doc. No. 3698. [2] Zellner B. (1979) In *Asteroids* (T.Gehrels, Ed.) pp. 783-806. [3] Chapman C.R. (1976) *Geochim. Cosmochim. Acta 40*, 701-719. [4] Bell J.F. (1986) *LPS XVII*, 985-986. [5] Gaffey M.J. (1976) *JGR 81*, 905-920. [6] Britt D.T. and Pieters C.M. (1987) *Meteoritics 22*, 340-342. [7] Britt D.T. and Pieters C.M. (1988) *Bull. Am. Ast. Soc. 20*, 863. [8] Housen K.R. et al. (1979) In *Asteroids* (T.Gehrels, Ed.) pp. 601-627. [9] Wetherill G.W. (1985) *Meteoritics 20*, 1-22. [10] Davis J.C. (1986) *Statistics and Data Analysis in Geology.* Wiley, NY. [11] Tholen D.J. (1984) *Asteroid Taxonomy From Cluster Analysis of Photometry.* Ph.D. Thesis, Univ. of Ariz., Tucson. [12] Zellner B. et al. (1985) *Icarus 61*, 355-416. [13] Britt D.T. and Pieters C.M. (1989) *LPS XX*, these volumes.

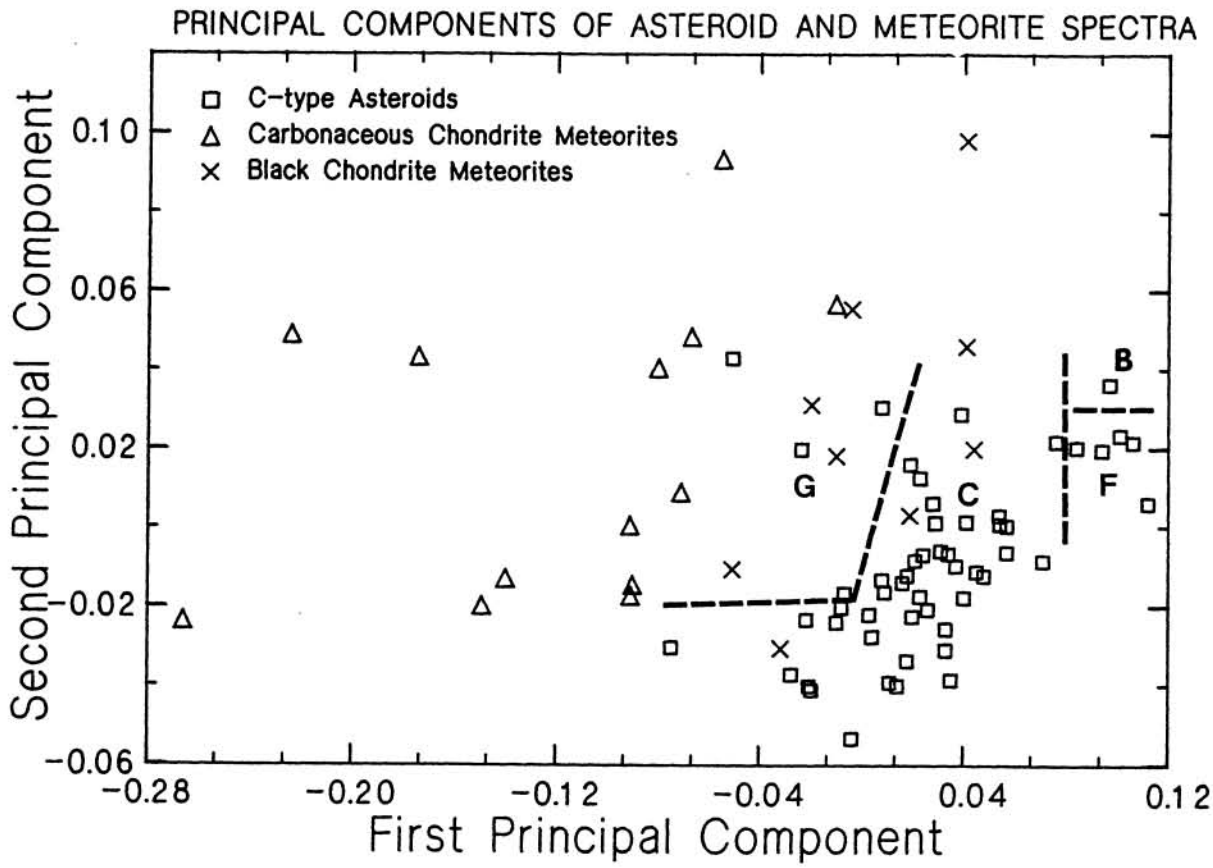

Figure 1: Principal components of asteroid and meteorite spectra. Dashed lines denote asteroid spectral types as classified by Tholen (1984).