

**MINERALOGY OF ORDINARY CHONDRITES AND IMPLICATIONS FOR ASTEROID SPECTROPHOTOMETRY.** Harry Y. McSween, Jr., Marvin E. Bennett, III, Dept. of Geological Sciences, Univ. of Tennessee, Knoxville, TN 37996, and Eugene Jarosewich, Dept. of Mineral Sciences, Smithsonian Institution, Washington, DC 20560

Quantitative data on the relative abundances of the constituent minerals of chondrites are necessary for proper matching, modeling, and interpretation of asteroid reflectance spectra. In light of the intense petrographic scrutiny that ordinary chondrites have received over the last century, it may seem surprising that a database of modal mineral proportions is not available. However, determining accurate modes of chondrites by point-counting is highly problematical because of difficulties in obtaining representative thin sections (1) and of distinguishing some silicate phases by optical properties alone. To correct this deficiency, we have determined the metal and sulfide abundances and calculated the normative silicate mineralogies of 94 ordinary chondrite falls from high-quality bulk chemical analyses (2). Norms are hypothetical mineral assemblages calculated from bulk chemistry. Although the compositions of normative minerals cannot be compared directly with actual mineral analyses (because of differences in the Fe/Mg distribution coefficient between olivine and pyroxene), the relative proportions of silicate minerals can be determined accurately.

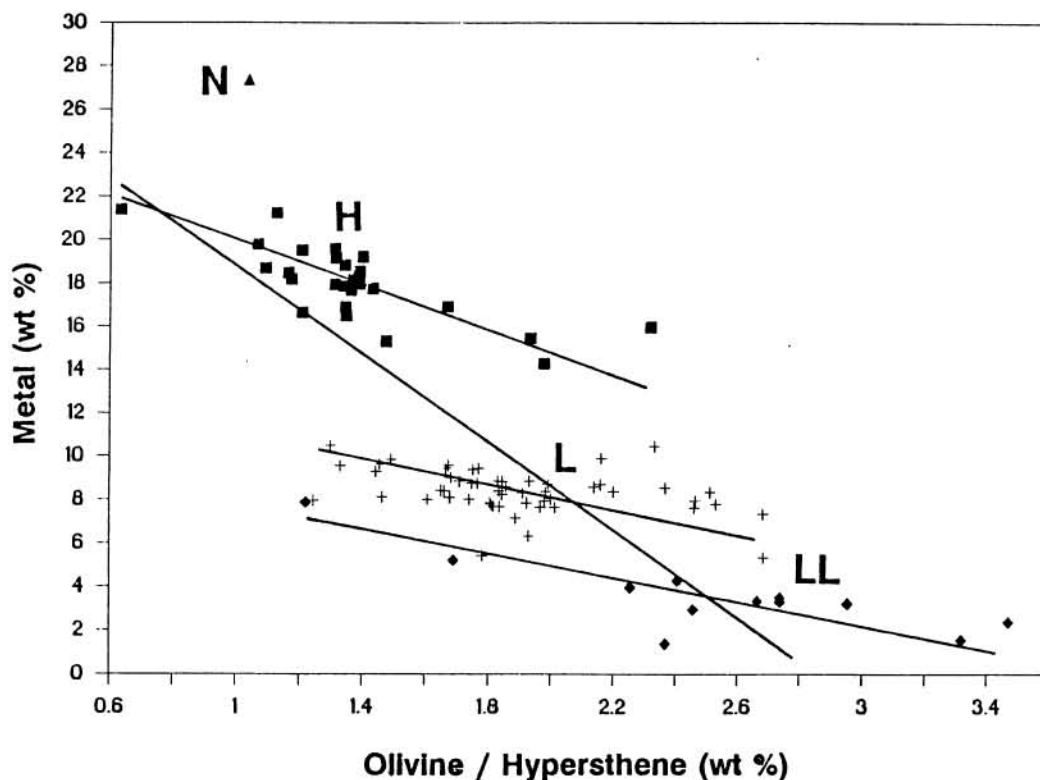


Figure 1. Relationship between abundance of metal and normative olivine/orthopyroxene ratio in H, L, and LL ordinary chondrites. Regression lines for each chondrite class and for the entire data set are shown. N refers to a chondritic (HH?) inclusion in Netschaevite.

**CHONDRITE MINERALOGY: McSween H.Y. et al.**

Based on these data, we conclude that the relative proportions of olivine, orthopyroxene, and metal are more variable within the H, L, and LL chondrite classes than has been previously appreciated. A plot of metal versus olivine/orthopyroxene ratio is illustrated in Figure 1. The variability in this diagram should serve as a caution for spectral studies that attempt to distinguish metal-rich from metal-poor chondritic asteroids based on similarities with spectrally analyzed individual chondrites. Variations in olivine/orthopyroxene ratio are not sufficiently diagnostic to define the different chondrite classes.

The short lines in Figure 1 are reduced major-axis regressions for each chondrite class, and the long line is a regression for the entire data set. The slope of the complete regression line is controlled by metal-silicate fractionation, and those for individual chondrite classes by differences in redox state. It has been widely recognized that metal fractionation was a critical event in the formation of chondrites and asteroids (3). The wide variations in mineralogy within the H, L, and LL groups (Figure 1), plus the recent identification of ordinary chondrites with transitional bulk and mineral compositions (4,5), offer support for the idea that there was originally a smoothly varying spectrum of compositions among asteroids. At least within the formation region for ordinary chondrites, the only systematic variant may have been the amount of metal versus silicate, and variations within any one class suggest that metal-silicate fractionation occurred even within the confines of one planetesimal feeding zone. A proposed systematic decrease in olivine abundance with heliocentric distance inferred for S asteroids (6) can be better explained by decreasing degrees of melting of chondritic bodies with increasing solar distance, followed by impact removal of basaltic crusts to expose source residues.

Using these mineralogical data, the properties of the various ordinary chondrite classes can also be extrapolated or interpolated to estimate the mineralogic characteristics of unsampled chondritic asteroids that formed under different redox conditions. One such chondrite, an HH(?) inclusion in Netschaevo (5), is identified by N in Figure 1. Its normative mineralogy is reasonably close to that predicted by extrapolating these data.

**References:**

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