CHONDRULES AND MATRIX IN THE SHARPS H3.4 CHONDRITE.

Alan E. Rubin[1] and Ernst Pernicka[2], [1]Institute of Geophysics, University of California, Los Angeles, CA 90024, USA; [2]Max-Planck-Institut für Kernphysik, 69 Heidelberg, FRG.

Previous studies of ordinary chondrite (OC) chondrules have demonstrated systematic changes in composition with petrologic type [1-3]. To minimize metamorphic effects it is necessary to study chondrules from the least-equilibrated type-3 chondrites. Petrographically-described OC chondrules have been analyzed by INAA in Dhajala (H3.8), Tieschitz (H/L3.6), Hallingeberg (L<3.5), Chainpur (LL3.4) and Semarkona (LL3.0) [2,4-7]. Most inferences about OC chondrule properties and precursor components have been made from studies of LL3 chondrules in Chainpur and Semarkona. To facilitate comparisons between chondrules and matrix in different OC groups, we analyzed by INAA and electron microprobe 19 chondrules and one matrix lump from Sharps (H3.4) -- the least equilibrated H chondrite fall.

Previous petrologic studies of Sharps chondrules [8-10] revealed a diverse array of chondrule types. Of the 19 chondrules in the present study, 7 are porphyritic (PO, POP and PP) and 12 are nonporphyritic (RP and C).

Similarities between H and LL chondrules

Relative to mean porphyritic chondrules, mean nonporphyritic chondrules have lower abundances of siderophiles and refractory lithophiles, higher abundances of Mn and higher Fe/Ni abundance ratios. Similar relationships were previously observed for other OC chondrules [e.g., Fig. 1 of 11]. Fe/Ni correlates moderately with Fs in the Sharps chondrules ($r=0.471$; $n=17$; $2\alpha=0.05$), indicating the presence of significant FeO.

Grossman and Wasson [11] found that refractory lithophiles anticorrelated with Fa and Fs in OC (mainly LL3) chondrules; they suggested that this was due to the mixing of refractory-rich, FeO-poor and refractory-poor, FeO-rich precursor components. A similar anticorrelation in Sharps chondrules suggests that H3 and LL3 chondrules formed from the same precursors. Factor analysis supports this suggestion: factors consisting of (1) siderophiles and chalcophiles, (2) refractory lithophiles, (3) alkalies and (4) common lithophiles match those of Chainpur chondrules [5]. Chondrule alkalies in these meteorites also show similar relationships: there are strong correlations between Na and K among the K-poor chondrules [5,12].

Differences between H and LL chondrules

Chromium and Mn correlate strongly among porphyritic (but not nonporphyritic) chondrules in Sharps ($r=0.924$; $n=7$; $2\alpha=0.005$). Porphyritic chondrules in H/L3 Tieschitz [2] show this correlation, but those in LL3 Chainpur and Semarkona do not. Thus Cr and Mn may have been in the same precursor component of porphyritic chondrules in H but not LL chondrites.

Grossman and Wasson [5-7] noted similarities between the lithophile and siderophile components of LL3 chondrules and those of whole-rocks. They suggested that chondrules formed after nebular fractionation events had established the compositional differences among chondrite groups. Because H chondrites have marginally resolvably higher refractory abundances than LL chondrites [13], this model implicitly predicts that such abundances in H3 chondrules are higher than those in LL3 chondrules. Refractory-lithophile/Mg ratios differ by <4% between H and LL chondrites; such small differences cannot be resolved in the chondrule data sets. However, Ir/Ni ($x10^5$) varies from 4.75 in H to 3.53 in LL chondrites [13]; among chondrules this ratio varies from 4.2±1.6 in Sharps (n=16) to 3.1±2.4 in Chainpur and Semarkona (n=87). Although the standard deviations in the chondrule Ir/Ni ratios overlap, a t-test shows that the means of the chondrule ratios are significantly different (t=1.759; 2α=0.10) and differ by almost exactly the same amount as the mean ratios of the whole-rocks. This suggests that there are primary systematic differences in composition between H and LL chondrules.

Gooding [4] suggested that an apparent enrichment in taenite Co (wt.%) in LL3 over H3 chondrules is primary, but his data are equivocal: (Tieschitz, 0.29±0.04; Dhajala, 0.38±0.12; Chainpur, 0.42±0.36; Semarkona, 2.0±0.8). Although taenite in Sharps chondrules (0.20±0.06) follows the proposed trend, it seems probable that (in meteorites other than Semarkona) metamorphic equilibration has affected these compositions.

Matrix material

A 0.66-mg lump consisting of 70 vol.% matrix material and 30 vol.% PP chondrule fragments was also analyzed. Abundances of refractory lithophiles, common lithophiles and common siderophiles are within 15% of mean H chondrites (except for V, 29% higher). Relative to H chondrites, alkalies are 30% low, Ir is 30% low and Se is 80% high. Fine-fraction matrix separates in other groups are also similar in composition to whole-rocks.

Conclusions

Chondrules in all OC groups formed from similar precursor components that were established by the same nebular fractionation processes that affected whole-rock compositions. Although chondrule compositions are heterogeneous, trends among the mean compositions of chondrules from different chondrite groups are similar to trends among the mean whole-rock compositions.

References: [1] Osborn (1972) Ph.D. thesis, Oregon State Univ.; [2] Gooding (1979) Ph.D. thesis, Univ. New Mexico; [3] Lux et al. (1981) GCA 45, 675; [4] Gooding (1983) Chondrules and Their Origins (ed. E.A. King) p. 61; [5] Grossman and Wasson (1982) GCA 46, 1081; [6] Grossman and Wasson (1983) GCA 47, 759; [7] Grossman and Wasson (1985) GCA 49 925; [8] Dodd (1971) CMP 31, 201; [9] Dodd (1968) GCA 32, 1111; [10] Dodd (1973) CMP 42, 159; [11] Grossman and Wasson (1983) Chondrules and Their Origins (ed. E.A. King) p. 88; [12] Kurat et al. (1984) EPSL 68, 43; [13] Wasson and Kallemeyn (1988) PTRSL, in press.