THE EXPERIMENTAL PRODUCTION OF MATRIX LUMPS WITHIN CHONDRULES: EVIDENCE OF POST-FORMATIONAL PROCESSES.

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INTRODUCTION The processes that acted upon chondrules after their formation are as important clues to the nature of the early solar nebula as are the exact processes that formed chondrules. Recent experiments (1,2,3,4,5,6) have studied the rim forming processes and the effects the processes have on chondrules. We present below information on how matrix inclusions (7) found within chondrules may have been formed and the potential usefulness of this information.

BACKGROUND It has been shown that the dominant process by which chondrule textures are produced is heterogeneous nucleation (8,9,10,11). With heterogeneous nucleation any solid, unmelted material present within a melt at the onset of crystallization will act as nucleation sites for the development of cyrstals. The experiments of (11) have shown that any particles introduced into a molten charge from outside of the charge will also act as nucleation sites and induce crystal development. Therefore, any relict material or introduced material in a molten chondrule will affect the type of texture produced, and clearly acts as nucleation sites. Therefore, because the "inclusions" reported by (7) had no effect on the crystallization of the chondrules that enclosed them it is unlikely that the "inclusions" were present at the onset of crystallization.

EXPERIMENTS Often, synthetic charges are produced that contain holes, or cavities where shrinkage during formation has permitted forming phenocrysts to grow in a pattern that uses all available melt and form a cavity (Fig. 1). Various synthetic chondrules that represent a wide range of initial formational conditions were selected based on the presence of small cavities or surface irregularities. Two techniques were used to produce matrix lumps, both utilising Fa100 material with a grainsize of 23 micrometers and less. The first technique followed the procedure of (1) and puffed dust onto charges that were placed back into the furnace. The second technique, after (1), coated charges with dust and placed them back into the furnace at 1000C for one minute.

RESULTS AND DISCUSSION Sections through dust filled cavities appear to show included lumps (Fig.2) The production of these inclusions or "matrix lumps" within synthetic chondrules depends on the presence of cavities or surface irregularities on charges before a rim forming event occurs. It also depends on how a section is made through the charges. If the section is not exactly through the cavity area, then the matrix lump is never observed. The production of cavities and surface irregularities within charges is a random and infrequent event. By analogy, the production of cavities and surface irregularities within natural chondrules must have also been an infrequent, random event. It has been stated (7) that matrix lumps may have been chondrule precursors that survived the melting event. An extensive search of experimental chondrule data has failed to reveal any experiments that report the survival of precursor material similar to matrix lumps. Even the recent flash melting techniques of (12,13) have failed to produce anything similar to matrix lumps. Clearly, if any precursor material did survive the melting event, it would act as nucleation sites for phenocryst development. It should be noted that it may also be possible to produce matrix inclusions by collision with a dusty surface (4), thus simulating some type of chondrule/parent body interaction.

CONCLUSIONS The production and observation of matrix lumps within chondrules depend on (1) the production of cavities and surface irregularities within chondrules during formation; (2) some type of rimming event that fills the voids and coats the chondrules with dust and (3) the exact sectioning techniques that will reveal these filled cavities. From our experiments matrix inclusions appear to be either rim or normal matrix material.

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MATRIX INCLUSION EXPERIMENTS: CONNOLLY, H.C.Jr. and HEWINS, R.H.

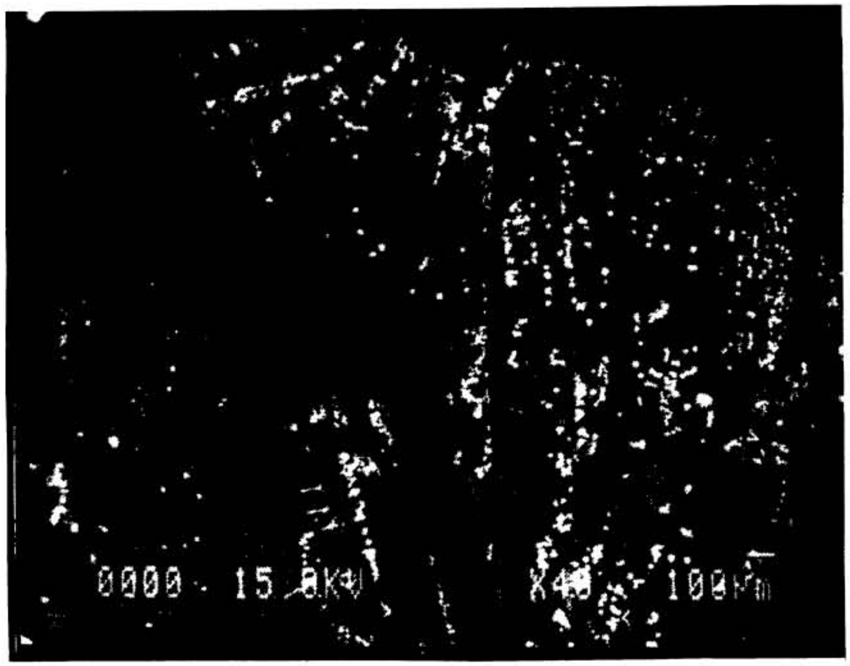

Figure 1. A backscatter image of the surface of a charge. Note the cavity in the center of the charge.

Figure 2. A backscatter image of a section from the charge in Fig.1. Note the cavity is now filled with dust. Both images were photographed at 40x.