CI1, CI2 AND CM2 CLASTS IN THE BHOLGHATI HOWARDITE AND THE AL RAIS CHONDRITE M.E. Zolensky[1] and R.A. Barrett[2], [1]NASA, Johnson Space Center, Houston, TX 77058, [2]Lockheed Engineering and Sciences Co., 2400 NASA Rd. 1, Houston, TX 77058

INTRODUCTION The presence in meteorites of clasts of greatly differing classes or types from the host are of great interest to meteoriticists and dynamicists because they indicate that representatives of these different materials were at one time in orbital proximity. This report is the first description of CI1 and CM2 clasts in the Bolghati Howardite, and a probable CI2 clast in the Al Rais chondrite. All reported analyses were performed by quantitative SEM-EDX techniques developed in our laboratory (described previously [1]).

BHOLGHATI CLASTS A.M. Reid called our attention to numerous small (>2 mm) black clasts present within Bholghati. Subsequent petrographic examination suggested that these clasts might be similar to matrix material from carbonaceous chondrites.

CM2 CLASTS IN BHOLGHATI Examination of seven of these clasts reveals that six closely resembled CM chondrite matrix material, consisting of olivine, Mg-Fe phyllosilicates and Fe-Ni sulfides. Sub-millimeter sized chondrules are also present. Figure 1 shows the average matrix composition of these six clasts plotted on a diagram of S/Si vs. Fe/Si, where it lies within the field defined by all CM matrix compositions determined to date [2-5]. Although we have yet to fully characterize the mineralogy of these particular clasts, on the basis of the petrography and matrix composition, we conclude that these clasts are CM2 material.

CI1 CLAST IN BHOLGHATI One of the Bholghati clasts exhibits the following interesting petrographic features: (1) no chondrule-like aggregates of anhydrous silicates (perhaps a sampling artifact due to the clast's small size - 1 mm), (2) abundant, small (<40 um diameter) aggregates and separate grains of magnetite with framboidal and spherulitic textures, (3) small (<30 um) aggregates and loose grains of fine-grained, anhedral pyrrhotite and pentlandite (principally the former), all set within (4) dense, opaque, extremely fine-grained dark matrix. All of these features are reminiscent of CI chondrites. This clast also contains one grain of olivine, which we suggest was physically inserted during incorporation of this clast into the Bholghati host unit. The composition of the pyrrhotite in this clast ranges from $Fe_{.82}Ni_{.03}S$-$Fe_{.88}Ni_{.01}S$, while that of the pentlandite cannot be determined besause of its fine intergrowth with the pyrrhotite. All of the analyzed magnetites were very pure Fe_3O_4. Fine-grained (<10 um) crystals of a Ca-carbonate are also present. The average of five matrix analyses are shown plotted on the S/Si vs. Fe/Si diagram in Figure 1, where it lies nearest the field of CI chondrite matrix compositions (we have, in the diagram, enlarged this field to encompass this clast). Therefore, we tentatively conclude that this clast is of CI material.

AL RAIS CI2 CLAST We recently noticed that one thin section of Al Rais (USNM 1794-1) includes an unusual clast measuring 3.5 x 3 mm. This clast contains no chondrules, in sharp contrast to the remainder of Al Rais, although there are scattered small anhedral grains of olivine with compositions Fo62-70 and Fo98-99. Only the latter range of olivine compositions is characteristic of the bulk of Al Rais [6]. These olivine grains are only observed within aggregates consisting predominantly of Fe-Mg phyllosilicates, magnetite and

Fe-Ni sulfides. There are, however, several rounded aggregates of phyllosilicates similar to what is observed in CM1 and CM2 chondrites [7]. The most striking features of this clast are several Ca-carbonate filled fractures running its length which are, of course, reminiscent of CI chondrites.

Set within the matrix of this clast are abundant, small (<100 um) aggregates of magnetite, sulfides and Ca-carbonate. Morphologies exhibited by the magnetite include framboids (individually <0.1 um), plaquettes, and subhedral crystal fragments (<5 um). The observed composition is always very pure Fe_3O_4. Many of the magnetite aggregates are coated with Ca-carbonate. All of these features are typical of CI chondrites. Pyrrhotite is the dominant sulfide, with an observed compositional range of $Fe_{.80}Ni_{.08}S$-$Fe_{.83}Ni_{.01}S$. Minor pentlandite occurs as intergrowths within the pyrrhotite.

The average of thirty matrix analyses is shown plotted on the S/Si vs. Fe/Si diagram in Figure 1, where it lies within the field of CI chondrite matrix compositions. The presence of any amount of anhydrous silicates appears to preclude classification of this clast as type 1, but rather suggests type 2. Faced with a similar predicament in the course of a recent study of the Yamato-82162 CI chondrite, Tomeoka et al. [8] proposed the classification CI2. Accordingly, we tentatively suggest that this Al Rais clast is also best described as CI2 material. Other similarities between this clast and Yamato-82162 include the Ca-carbonate veining, apparent lack of sulfates, and presence and morphologies of magnetite and sulfides [5, 9]. We suggest that other clasts of this material may be found elsewhere within Al Rais, hopefully in amounts which will permit a more conclusive characterization.

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Figure 1