CHARACTERISTICS OF REMELTED ALLENDE CHONDRULES AND MATRIX.


As part of a more general observational and experimental investigation into the conditions under which various components in unequilibrated meteorites may have formed we have melted several Allende matrix samples and have remelted several Allende chondrules. This was done in the miniature graphite furnace of our atomic absorption apparatus (1), which provided conditions as reducing as plausible for any chondrule formation environment. Samples were rapidly heated to maximum temperatures in the range from 1350°C to 1750°C, held there for 2-3 seconds, and then cooled at 300-400°C per second.

The above procedure has the obvious shortcomings that sample compositions are not known in advance, and that the cooling rates are not controlled. Despite these, because of the very realistic nature of the starting materials, it provides important general information complimentary to that provided by previous more comprehensive and well controlled synthetic chondrule experiments starting with glass or oxide powders (2-4). It also provides information directly applicable to interpreting features seen in Allende chondrules.

The most important general feature observed in all our runs so far is that Na loss is almost complete while reduction of iron is fairly limited, even though the environment is highly reducing. Although kamacite is present in most samples, high FeO silicates and pentlandite always remain. This seems to rule out the possibility that chondrules could be produced by melting matrix in a reducing environment followed by the separation of reduced metal.

Except for containing large bubbles of doubtful significance, chondrules remelted at about 1500°C generally have textures typical of fresh porphyritic or microporphyritic chondrules as illustrated in Fig. 1a. A large fraction of the glass in actual Allende chondrules has been altered to secondary phases.

As expected with this thermal history, most of the forsteritic olivine in these remelted chondrules consists of relatively unchanged relic grains. As evidence of this the trapped melt inclusion shown in Fig. 2b is rich in Na and K, while these elements are undetectable in the nearby mesostasis glass. Little grain growth of olivine or crystallization of material from the glass is evident in the remelted chondrule illustrated in Figs. 1a and 1b.

In other cases several microns of olivine grain growth occurred, accompanied by the growth of micron sized crystals from the melt. This is illustrated in Figs. 1c and 1d. In general we believe the effect of remelting chondrules to this degree is largely to restore them to a conditions closely resembling their state before they were subjected to low temperature alteration.

In these remelted chondrules we never see magnetite, porous pentlandite, or Ca phosphate. These are all things we previously interpreted to be products of low temperature alteration (5). However, we do see virtually unaltered the healed cracks containing submicron chromite forcing us to consider the possibility that they formed at high temperature, probably by the oxidation of Cr+++ which was in the olivine. The presence of 1 um sized chromite grains as shown in 1c and 1d, which are never seen in untreated Allende chondrules, indicates that Cr was not in the Cr+++ state when the chondrules formed.

REFERENCES

Fig. 1. Scanning electron micrographs of remelted chondrules. Microporphyritic texture in one remelted chondrule is illustrated in a and b along with submicron chromite along healed cracks. Grain growth of large olivines is illustrated by the backscattered electron images in c and d. About 1 micron of darker, more Mg-rich olivine surrounds the olivine cores on the right in c and on the bottom in d. This in turn is normally zoned to a very Fe-rich rim. Bright euhedral 1 um chromites are evident in the mesostases in c and d.