NEW EVIDENCE OF RELICT GRAINS IN CHONDRULES OF HIGHLY UNEQUILIBRATED ORDINARY CHONDRITES. Ermanno R. Rambaldi, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024, USA.

Recent textural and compositional data on chondrules from highly unequilibrated ordinary chondrites have shown that some chondrules contain relict silicate grains that survived the chondrule formation process without melting. These chondrules, therefore, are not the crystallization products of completely molten silicate assemblages.

In the majority of cases the relict grains consist of forsteritic olivine; less frequently, of enstatitic pyroxene. The most common occurrence is as highly corroded crystals of forsterite containing dusty inclusions of metal (>98% Fe) generally in the core of the grains. The FeO zoning and the minor element composition of these grains are inconsistent with crystallization from a melt and in disequilibrium with the igneous surrounding material in the chondrule. These types of chondrules were discussed by Rambaldi (1981) and Rambaldi and Wasson (1982). We now report the discovery of possible relict grains in additional types of chondrule textures.

Fig. 1 shows a chondrule from St. Mary's County containing large olivine grains surrounded by a microcrystalline groundmass of fibrous silicates. The olivine grains display clear evidence of strong corrosion and contain droplet-like overgrowths that are considerably richer in FeO (up to 25%) than the bulk of the grain (less than 10% FeO). Fig. 2 shows a chondrule containing large orthopyroxene laths of enstatitic composition. The interior of these grains is polysynthetically twinned and is surrounded by an outer zone of similar composition where the twinning has been annealed. The grains are highly corroded and are coated by a thin ($\leq 10\,\mu m$) rim consisting of an inner layer of Ca-poor pyroxene ($\sim 2\%$ CaO) and an outer layer of clinopyroxene. The interstitial material consists of alkali-rich glass with µm-sized inclusions of euhedral clinopyroxenes.

In both cases there is strong evidence that the heating event, recorded in the texture and composition of these chondrules, did not completely melt the mineral assemblage and that the highly corroded grains are relicts. The complexity of events that led to the formation of some chondrules is recorded in some cases in which small chondrules are found included in the interior of large chondrules from which they differ in texture and/or composition. Two of such cases are shown in Figs. 3 and 4. In both cases there is no evidence of deformation, which seems to exclude the possibility of a collision between a previously existing, hot (and thus deformable) host chondrule and the chondrule inclusion. In the first chondrule a major set of fractures cuts across both the chondrule inclusion and the adjacent euhedral olivine grains of the host chondrule, while incipient melting appears to have affected the olivine porphyritic host chondrule and the barred olivine chondrule inclusion on Fig. 4.

Cases of chondrules within chondrules have been found in most of the highly unequilibrated chondrites surveyed. In several cases the chondrule inclusions appear to be representative of one

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of the precursor constituents of the host chondrule. It is clear that chondrule formation occurred over an extended period of time, and that debris from earlier chondrule generations could be the source of the relict grains in the incompletely melted chondrules.

References: (1) Rambaldi E.R. (1981) Nature 293, 558-561; (2) Rambaldi E.R. and Wasson J.T. (1982) Geochim. Cosmochim. Acta, in press.

Fig. 1

Fig. 2

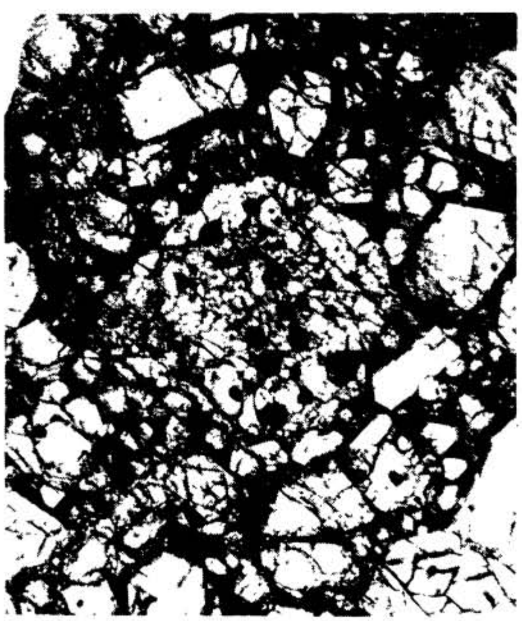

Fig. 3

Fig. 4