MICROCHONDRULES: THEIR OCCURRENCE IN NEW KINDS OF TYPE 3 CHONDRITES AND THEIR BEARING ON THE ORIGIN OF CHONDRULES. Alan E. Rubin, Edward R.D. Scott, Klaus Keil and Akihiko Okada, Department of Geology and Institute of Meteoritics, University of New Mexico, Albuquerque, NM 87131, USA.

The major components in type 3 chondrites are an Fe-rich, fine-grained opaque (or recrystallized) silicate matrix, grains of metallic Fe,Ni and FeS, and sharply defined chondrules of various types. Radial pyroxene chondrules, which consist of fan-like arrays of low-Ca pyroxene and accessory amounts of glass, compose 7-9% of all chondrules in type 3 H, L and LL chondrites, 0.5-1.5% of those in CO3 chondrites, but are absent in CV3 chondrites (1,2). Chondrule sizes vary according to chondrite group: $\geq$90% of the chondrules in CM2 and CO3 chondrites are 0.055-0.8 mm in diameter, whereas in CV3 and type 3 H, L and LL chondrites, chondrules are larger, 0.15-2.8 mm and 0.09-1.7 mm in diameter, respectively (3,4). We have identified microchondrules (chondrules $\leq$100 μm in diameter) in two new kinds of type 3 chondrite clasts, where they are abundant, and in type 3 ordinary and carbonaceous chondrites, where they are rare.

The first "microchondritic" clast is ∿0.8 x 0.2 mm in size and was found in a thin section of the Piancaldoli LL3 chondrite. The clast contains ∿100 radial pyroxene microchondrules, 0.25-64 μm in apparent diameter, opaque matrix with a composition typical of type 3 chondrites, and minor metallic Fe,Ni and FeS. Most of the microchondrules are zoned, with margins that are enriched in iron. Three features of these chondrules are unique: their Rosin size-distribution, their sizes (which are much smaller than any previously reported for chondrules), and their single textural type. There is a significant inverse correlation between chondrule size and FeO content (the first such correlation to be documented). These features, as well as the high modal matrix abundance (63 vol.%), lack of observable olivine, and a bulk composition unlike those of established chondrite groups, serve to identify this clast as a new kind of type 3 chondrite.

The second microchondritic clast was found in a thin section of Rio Negro, an L chondrite regolith breccia, and has an apparent diameter of 5 mm. Like the Piancaldoli clast, it contains all the above-listed major components of type 3 chondrites. There are 25 radial pyroxene and olivine-pyroxene-rich microchondrules, 11-74 μm in diameter, a single 500 μm-diameter poikilitic olivine-pyroxene chondrule and several porphyritic olivine-pyroxene chondrule fragments of comparable size in the Rio Negro clast. Fodor et al. (5) described this clast, but did not identify the microchondrules. The bulk composition and abundance of mineral grains and aggregates of this clast distinguish it from the microchondritic clast in Piancaldoli. Histograms of olivines and low-Ca pyroxenes in the Rio Negro clast are very similar to those of the metamorphosed CO3 chondrites, Isna and Warrenton (5). These similarities, as well as the occurrence of dehydrated layer-lattice silicates in the clast (5), an opaque matrix composition similar to that of carbonaceous and L-group ordinary chondrites, and a bulk composition similar to that of carbonaceous chondrites, suggest that the Rio Negro clast is a new kind of microchondrule-rich type 3 chondrite, possibly related to C3 chondrites.

We have also found four or five radial pyroxene microchondrules, 55-80 μm in diameter, in each of the following meteorites: Bremervörde (H3), Dhajala (H3), Sharps (H3), Inman (L3), Allan Hills A77003 (CO3), Kainsaz (CO3) and Lancé (CO3). (Radial pyroxene chondrules in Allan Hills A77003 also show a significant inverse correlation between chondrule size and FeO content.) In

addition, Inman, Kainsaz and Lancé each contains three or four pyroxene and olivine-pyroxene microchondrules, 12-45 μm in diameter. The occurrence of microchondrules in microchondritic clasts and type 3 ordinary and carbonaceous chondrites indicates that the microchondrules represent a previously undescribed constituent of the early solar system that was available to agglomerate with other components to form chondrites.

Size-sorting of chondrules (or their dustball precursors) is indicated by the existence of microchondritic clasts and the occurrence of chondrules of different size ranges in different type 3 chondrite groups. Plausible size-sorting mechanisms include the Poynting-Robertson effect, aerodynamic drag (6,7), and gravitational (8) and electrostatic (9) sorting. In contrast to the Rosin size-distribution of microchondrules, normal-sized chondrules in ordinary chondrites have a Weibull size-distribution (10), which Martin and Hughes (10) suggest was a primary feature of chondrule formation. However, the removal of numerous small chondrules from a chondrule set with a Rosin distribution could have produced the Weibull distribution of normal-sized chondrules (10) and the Rosin distribution of microchondrules. The evidence for size-sorting presented above suggests that this happened.

The observations that most compound chondrules in ordinary and carbonaceous chondrites consist of chondrules of the same textural type (1,2) and that chondrites contain many different types of chondrules indicate that different chondrule types formed at different locations (or at different times) in the nebula and were mixed together prior to chondrite agglomeration. The Piancaldoli clast, which contains only small chondrules of one textural type, must have agglomerated after size-sorting, but before mixing of different chondrule types. The Rio Negro clast, which contains a few types of chondrules of different sizes, probably experienced less size-sorting, but some mixing of different chondrule types. A large number of as yet unknown kinds of chondrites may exist that have different proportions of chondrules of various types and sizes due to differences in mixing and sorting of chondrite constituents prior to agglomeration.

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