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Predominance of porphyritic textures in chondrules due to density sorting of precursor materials? Constraints from melting experiments

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Although chondrule textures are diverse, the absolute number of texture types is relatively small essentially encompassing cryptocrystalline (glassy) to microcrystalline (radial pyroxene), barred, granular, metallic and porphyritic/micro-porphyritic varieties; and the vast majority (~70–90 %) of all textures are a variety of porphyritic (e.g., porphyritic olivine). Here, I show experimentally that when charges are heated initially at 1550 ◦C that differences in the bulk compositions have an enormous effect on ultimate texture. I construct several bulk compositions by mixing varied quantities of olivine with plagioclase and pyroxene. When synthetic chondrule materials are heated below their liquidus (maximum 1718 ◦C), the predominant texture is porphyritic if olivine (liquidus of ~1844 ◦C) is abundant. If more easily fusible dust (En + An liquidus of 1429 ◦C) is abundant, barred and glassy chondrule textures result. Assuming amoeboid olivine aggregates (AOA) are possible precursors, I also replaced olivine by synthetic (pre-sintered) granoblastic olivine aggregates (GOA) and isothermally produced PO chondrule analogs when 'AOA' (with En + An) mixtures have Ol: En + An ratios of 99:01 to 30:70, but glass-rich analogs at mixtures with ratios of 20:80 and 10:90. If charges are subsequently cooled at 1000 ◦C/h to 100 ◦C/h after an isothermal dwell of 1 h at 1550 ◦C, PO analogs prevail at ratios of Ol:En + An of 30:70 and (presumably, based on isothermal experiments) higher, barred olivine (BO)-like analogs occur at ratios of 20:80; elongated skeletal hopper olivine (EHO) ensues at ratios of 10:90. Models of chondrule formation have not explained the propensity of PO textures but these experiments suggest simply that the predominance of PO chondrules is largely a function of the abundance of Mg in the chondrule precursors and that the ratio of olivine to dust was high in chondrule precursors. Stratification of chondrule precursors may have occurred before chondrule formation, resulting in a greater volume of denser olivine in the central region and greater volume of less dense, fusible An+En in the periphery. Results are compatible with large chondrule-forming regions with a great variety of chondrules being formed in the same event(s) at the same temperature.