Solute Banding: Manifestations in Solidifying Lunar Magma Oceans

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Estimations of radiative and convective heat transfer in a magma ocean are combined with industrial experience with solidifying melts to yield a scenario for solidifying lunar basalts of extensive depth. Laboratory and industrial experience indicate viscosity variations with temperature to be responsible for solidification from the top downward in melts cooling from the top. This combined with surface tension which initially enmeshes crystals at the surface, provides structure for initiating downward growth. Convection may continue vigorously up to 55% crystal content at which point there is a snap-through increase of viscosity by many orders of magnitude. This creates a highly viscous top boundary layer sustaining crystals suspended in a glassy melt and preventing sinking. Further cooling sees to freezing in the sense that viscosities become so high in the upper most layers that convective motion is nil. Convection does continue below the downward growing crust, but it's vertical extent decreases with continued cooling. In a sense, crystal-glass "glue" constitutes a ceiling that grows downward. The initial ceiling will form first from the high temperature components, e.g., in an initially-homogeneous olivine-plagioclase melt, the crust will be enriched in Fo, An, the melt immediately beneath it depleted in Fo, An, hence enriched from the original composition in Fa, Ab. This stratification of an initially homogeneous melt may bring into play Soret processes serving to fractionate isotopes, and chemistry. The length of time required to cool the magma ocean, may, however, see to recurrent homogenization of remaining magma.