

Crystallization experiments of Los Angeles basaltic shergottite.

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Los Angeles (LA) is a coarse-grained basaltic shergottite composed of pyroxene and maskelynite. Pyroxenes in this meteorite are pigeonite and augite, and both pyroxenes are extensively zoned from relatively Mg-rich cores to Fe-rich rims. The Ca zoning pattern is complex and pigeonite and augite are irregularly distributed unlike other basaltic shergottites. Because LA has high plagioclase abundance similar to QUE94201, there is a possibility that the LA bulk composition represents a parent melt composition, although these two shergottites show distinct pyroxene zoning patterns. In this study, we performed crystallization experiments using the LA bulk composition to investigate the crystallization history of LA. We also compared LA mineralogy with that of Dhofar 378 (DHO) which shows a lot of mineralogical characteristics similar to LA, and applied the experimental result to explain the differences between LA and DHO.

In the crystallization experiments, the homogenized glass were cooled from slightly above the liquidus temperature (1155 C) to 800 C at 2.5 C/hour under the oxygen fugacity of QFM-1.3 (estimated oxygen fugacity of LA) that were controlled by the gas mixture of CO₂-H₂.

The run product consists of pyroxene, plagioclase, Fe-rich olivine, and Fe-Ti oxides. Synthetic pyroxene is zoned from the Mg-rich augite core to the Fe-rich rim with lower Ca content, although hedenbergite formed at the pyroxene edges. The texture of the run product suggests the following crystallization sequence. (1) Mg-rich augite core crystallized. (2) Plagioclase started crystallizing with the Fe-rich pyroxene rim. (3) After the end of pyroxene crystallization, fayalitic olivine (Fa₈₃₋₉₀) began to crystallize. Synthetic pyroxenes are all high-Ca pyroxenes, and there is no Mg-rich pigeonite that was present in LA. However, the zoning sequence shows a similar trend between synthetic and natural LA pyroxenes. When the charge could have been cooled more slowly, plagioclase crystallized first and then low-Ca pyroxene might have crystallized. Otherwise, the parent melt of LA is more Mg-rich and Ca-poor than the bulk LA composition because LA seems to be a fractionated sample. We prefer the latter scenario because LA should have cooled fast enough to preserve chemical zoning of pyroxenes.

DHO is composed of subequal amounts of pyroxene and maskelynite, and shows mineralogical characteristics similar to LA. Both pigeonite and augite are zoned from the Mg-rich cores to the Fe-rich rims, and their compositions are similar to those of LA. In addition to the pyroxene composition, DHO resembles LA in lithology, grain size, and mineral assemblage. However, a complex mixture of hedenbergite, fayalite and silica abundant in LA is absent in DHO in spite of their striking mineralogical similarities. Because DHO contains abundant vesicles that are not seen in LA, DHO must have experienced a higher shock degree than LA. Probably, higher shock degree of DHO melted these phases although they were originally present as seen in LA. Some areas in DHO include euhedral fayalite with Fe-rich pyroxene and the mesostasis. These areas are considered as originally pyroxferroite breakdown products that melted by shock and subsequently recrystallized. Because the pyroxene compositions of LA and DHO are similar, the slower cooling also may be able to reproduce the pyroxene in DHO. However, our 2.5 C/hour cooling run could be comparable to the cooling rate for recrystallization of DHO from shock melt. The run product crystallizes euhedral fayalite with Fe-rich pyroxene at their last crystallization stage. The chemical composition of synthetic fayalite is similar to that in DHO (Fa_{~85}). Therefore, we believe that the recrystallization of Fe-rich phases from the shock melt of DHO was reproduced at the last stage of our 2.5 C/hour cooling experiment.

The coming results of slower cooling experiments will tell more about the crystallization of LA and DHO.