CRYSTALLIZATION HISTORY OF PLAGIOCLASE FROM LUNAR BASALT 12021,
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The plagioclase in lunar rocks has not been analyzed chemically in the same detail as the pyroxenes. As a result their usefulness in interpreting the crystallization history of these rocks has not been fully exploited. The plagioclase from sample 12021, 148 was chosen for investigation because it is coarse grained, clearly zoned, and because the pyroxenes in this rock have been thoroughly analyzed. The important features of these plagioclase grains are:
(a) the tabular grains, many forming initially as hollow crystals;
(b) the zoning of both major and minor (K, Mg, Fe) elements; and
(c) the non-stoichiometry of all but the most calcic portions of the crystals.

The shape of the alternating more calcic and more sodic zones, as well as the minor element distribution indicate that the most sodic plagioclase, An 88, crystallized first. The early crystals are rectangular hollow boxes bounded by thin (010) and thicker (001) plates. Commonly only one end of the resulting hollow core elongated parallel to a remains open. From this initial skeletal crystal, crystallization proceeds both outward and inward to a more calcic plagioclase which finally reaches a composition of An 95. Zoning inwardly is commonly much more abrupt than the outward zoning and in some grains the outward zoning is oscillatory but the outer sodic zone is not as albitic as the initial inner one.

The concentration of minor elements is greatest in the more sodic plagioclase except right at the margins of the grains. The ratios Fe/Fe+Mg and K/K+Na increase systematically outward and inward from the initial crystal. These ratios do not depend on the plagioclase composition but rather are close to the values in the pyroxene and the liquid present at the time each portion of the plagioclase grew. Therefore it is possible to trace the crystallization history of the plagioclase relative to the other phases in the rock. Fe/Fe+Mg of the initial plagioclase is .61 to .64, the same as that of the "pigeonite band" (Boyd, 1971) in the pyroxene. Evidence from the Al content of the pyroxenes and from the textural relations between pyroxene and plagioclase suggest that the plagioclase first appeared at this stage in the growth of the pyroxene grains. The Fe/Fe+Mg ratio reaches .98 to 1.0 in the outermost zones of the plagioclase. The K/K+Na ratio is appreciable only in the last plagioclase to crystallize as would be expected from the very minor abundance of K-rich phases in the mesostasis of the sample.

The early crystallized more sodic plagioclase shows the greatest departure from the stoichiometric feldspar composition. It also commonly contains pyroxene inclusions elongated parallel to the plagioclase a axis. These may represent pyroxene nuclei trapped by rapid plagioclase growth or they may be due to exsolution from the plagioclase. Where there is a late zone of sodic plagioclase it is also non-stoichiometric but not quite as much as the earlier feldspar of the same composition. As the plagioclase becomes more calcic, the degree of non-stoichiometry decreases, and at An 95 the...
silica content reaches its stoichiometric value. Alumina, however, remains less than would be expected. The approach to stoichiometry probably reflects the increased order required by the plagioclase structure for compositions of An 95-100.

The plagioclase grain shapes and compositions suggest a single stage of cooling, without significant magma movement once plagioclase started to crystallize. The reverse and oscillatory zoning and the dissimilarity of the inward and outward zoning profiles suggest rapid, diffusion-controlled crystallization from a magma in which local compositional fluctuations arise due to rapid disequilibrium crystallization of plagioclase and pyroxene. This type of detailed analysis suggests that it should be possible to recognize whether the plagioclase in a sample crystallized in equilibrium with the other phases present or whether it represents an accumulation of crystals separated from its primary magma by settling or flotation.

Reference