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Plagioclase-chain networks in slowly cooled basaltic magma

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ABSTRACT

Plagioclase crystals in the slowly cooled interior of the thick Holyoke flood-basalt flow of Connecticut linked to form monomineralic chains at an early crystallization stage. Partial melting experiments reveal that when the quartz tholeiite was only 25% crystallized the chains had already linked to form a continuous 3-D network. At such an early stage of crystallization, the network was weak, highly permeable, and easily deformed. Consequently, the mush of plagioclase-chains and interstitial pyroxene crystals underwent compaction in the lower third of the flow with the expelled liquid rising to the center of the flow where it crystallized to form coarse-grained sheets of fractionated basalt.

Plagioclase chains are most easily seen in the basalt after it has been partly melted and the late crystallizing minerals converted to glass. The chains are several crystals wide. The crystals, which are ~0.5 mm long, are attached together randomly. Normal zoning patterns indicate crystals had a brief period of growth before linking together. The chains branch every few millimeters to form the 3-D network, which was mapped using serial polished sections and X-ray CT scans. The chain frequency measured along vertical and horizontal traverses decreases toward the center of the flow. In the compaction zone, the frequency in the vertical direction is greater than in the horizontal. Making the reasonable assumption that these frequencies were initially the same, the difference is used to calculate the degree of compaction. The resulting pattern through the flow matches almost exactly the pattern indicated by variations in the incompatible elements. Plagioclase chains are also found in some coarser-grained plutonic rocks. If they are common, their fabric may provide a new, direct means of measuring the degree of compaction in crystal mushes.