Crystallization History of the 1984 Mauna Loa lava Flow

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During a three week eruption in 1984, Mama 1,oa produced vent lavas that increased in crystallinity from <1 to 30%, and 27-km-long flows that increased in crystallinity as they moved downstream, Crystal-size distribution (CSD) analysis of samples was used to study the rates of crystallization, viscosity increase, ant] latent heating in these lavas. Typical average growth and nucleation rates were 5 x 10^{-9} cm s^{-1} ant] 5 cm^{-3} S-I for microphenocrysts (20-500pm size crystals that nucleated in the rift zone) and 10^{-7} cm s^{-1} and 105 cm^{-3} S-l for microlites (1-20 pm size crystals that nucleated in the channel). These crystallization rates are high compared with those fount] in other CSD studies of igneous rocks, probably due to highly nonequilibrium conditions brought on by degassing in the rift zone and cooling in the lava channel. Growth and nucleation rates decreased with time at the vent and with distance downstream. The maximum downstream tots] crystal linity measured is 39% (25% microlites, 14% microphenocrysts) in a quenched sample 14 km from the vent. Growth and nucleation rates cannot be calculated for postemplacement samples, but they place upper limits of 53-58(% on the amount of crystallization in the channel 9-20 km from the vent. Crystallization could have been mostly responsible for the 10^{5}-fold downstream increase in apparent viscosity, although degassing and increasing incorporation of solid lava fragments also contributed. Another effect of crystallization was the sizeable latent heating (0.01 J g^{-1} s^{-1} over the first half of the flow length, if the crystallinity of downstream quench samples is representative of the hot fluid core), which may have been counteracted by entrainment of cooler material, Measurements of crystallization are found to be crucial in the study of lava-flow emplacement dynamics.