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Degassing and crystallization during magma ascent in the initial explosive phases of the 2021 eruption of La Soufrière, St. Vincent

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In the last 500 years, La Soufrière Volcano on St. Vincent has erupted effusively and/or explosively in at least seven episodes. The most recent period of eruptive activity began in December 2020, with effusion of a lava dome, culminating in a series of Vulcanian and sub-Plinian eruptions between April 9th and 22nd, 2021. Detailed petrographic analysis of vesicular scoria samples from three units (U1-U3), erupted within the first 48 hours, allows us to place constraints on what may have triggered the explosion and processes that occurred during magma ascent. The scoria was basaltic andesite, with plagioclase + orthopyroxene + clinopyroxene + olivine + titanomagnetite. All crystals feature euhedral margins and appear to be in textural equilibrium with the groundmass glass, but they are rarely in chemical equilibrium with the melt (or each other), based on K_D analysis. The phenocryst abundances and populations in all three explosive units (and lava dome) span similar compositional ranges. However, microlite compositions/abundances and vesicle sizes are distinctive. The initial explosive phase, U1, is characterized by An-rich plagioclase microlites (up to An_{96}), comparable abundances of opx ($Mg\#_{0.64-0.70}$) and cpx ($Mg\#_{0.66-0.73}$), and abundant olivine microlites. In contrast, microlites in U3 are dominated by more sodic plagioclase (An_{46-65}), a preponderance of opx ($Mg\#_{0.49-0.67}$), and rare cpx and olivine (Fo_{59-79}). With respect to the vesicles, bubbles appear to be coalescing as the eruption progresses, with increased time between bubble nucleation and explosions. In U1, >60% of the bubbles are <10 um, whereas U3 samples have <20% of bubbles <10 um. During lava dome effusion, the SO_2 efflux was low, and the SO_2 content (1914 tonnes/day) recorded during the initial Vulcanian blast was smaller than expected if the magma was gas rich, and significantly less relative to the later explosions. Thus, gas may have been initially stored in the shallow conduit as a separate fluid phase and subsequently released by the explosion. The fresh magma column was likely super saturated with few/no bubbles present until the initial explosion caused a decompression event and changed the degassing from closed system (during lava dome growth) to open system degassing.