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Magmatic Pathways Feeding the 2021 Paroxysmal Events at Mt Etna: A Mineral Perspective

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Mt. Etna, Italy, is one of the most active and intensely monitored volcanoes on Earth. The volcano produces relatively homogeneous trachybasaltic compositions in eruptions that vary from effusive to explosive. Since 1986, Mt. Etna has experienced over 240 short, explosive events (paroxysms) at its summit craters. The paroxysms are characterised by Strombolian activity followed by lava fountaining and may pose increased hazards relative to the regular activity.

Here, we explore pre-eruptive histories in the February – March 2021 paroxysms and compare results to non-paroxysmal activity. We apply high-resolution major, minor and trace element geochemistry to clinopyroxene and plagioclase crystals from lava flow and pyroclastic products. Clinopyroxene is an early crystallising phase in Etnean magmas, providing information on relative deep levels within the plumbing system. In the 2021 products, clinopyroxene (Mg# = 73) occurs as phenocrysts (>400µm crystal length), microphenocrysts (200-400µm) and groundmass microcrysts (<100 µm width). Crystals typically have Cr-rich bands, which signals the input of mafic magma into the system. These bands can surround recycled, Na-rich cores which likely formed at depth. Additionally, sector-zoning is common, with rims typically stronger partitioning between the sectors than the cores, suggesting crystallisation at higher undercooling conditions, likely during ascent. Overall, crystals in lava flows, bombs and lapilli products show similar compositions. In contrast, plagioclase is a late crystallising phase at Etna and forms in shallow regions of the plumbing system upon degassing, developing a wide range of disequilibrium textures. In our lava and bomb samples, plagioclase occurs as phenocrysts and groundmass microcrysts, and is commonly normally and/or oscillatory zoned, with sieved cores. In contrast, plagioclase crystals from lapilli are intensely sieved and are unzoned except for very thin An-poor rims. We interpret these products to be formed after eruption-triggering magma recharge in the shallow regions of the plumbing system, correlating with Cr-rich recharge bands in clinopyroxene. Overall, crystal textures and compositions in 2021 are similar to those in non-paroxysmal eruptions, but ubiquitous disequilibrium textures in plagioclase from 2021 lapilli suggest key differences in final magma ascent and degassing prior to paroxysmal explosions.