Large explosive eruptions are often characterized by compositionally differentiated, crystal-poor juveniles. As generally accepted, the formation of differentiated magmas implies fractionation of crystals, in variable amount depending on the composition of parental magmas. Thus, aphyric-sub-aphyric textures can be explained only invoking efficient crystal-melt separation processes. Mechanisms of crystal-melt separation (e.g. crystal settling, convective fractionation, mass transport via thermal gradient, melt migration induced by crystal compaction) so far proposed, are mainly based on theoretical models and natural evidences but poorly experimentally constrained.

In this work, we have experimentally investigated crystallization and crystal-melt separation in presence of a thermal gradient as a possible mechanisms for the origin of crystal-poor, differentiated magmas. The crystallization degree varies as a function of the thermal gradient in the experimental products. Backscattered images reveal, from the bottom to the top of the charge, the presence of: a glassy zone; drop-shaped clusters of crystals; moderately-highly porphyritic (mushy) zones; glassy belts and pockets separated from the porphyritic zone by a thick rigid crystal framework (>80vol%). These textures demonstrate that aphyric melts can originate even in crystal-rich environments by the collapse of unstable solidification fronts. We advocate that experiments performed in the presence of a thermal gradient reproduce environmental conditions of vertically shaped, thermally zoned, magma chambers. Experimental textures, compared with natural ones, demonstrate that the development of a solidification front at the roof of a thermally zoned magma chamber may be the controlling mechanism for crystal-melt separation and the origin of large volumes of crystal-poor magmas.