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Magma mingling caused by explosive fragmentation during magma chamber replenishment

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Intrusion of new magma into a magma chamber is a common process that can be identified in the products of volcanic eruptions or in fossil magma chambers and it is claimed as an efficient trigger of explosive eruptions. In general, the main changes that a new intrusion of magma will cause on the resident magma consist of a sudden increase of magma pressure and temperature; the latter inducing forced convection and chemical diffusion between the two magmas. The effects of such process may alter the crystallisation of the resident magma till the extent of cancelling it by triggering a new eruption. The original structures and textures, in addition to chemical changes, derived from magma-in-magma intrusions may be preserved in fossil magma chambers, such as granitic batholiths. The study of these fossil structures may help to decipher details of the complex processes involved in magma chamber replenishment. In these cases it is commonly observed how intrusion of mafic magma into a felsic magma chamber resulted in the desegregation (fragmentation) and further distribution of the new magma in the form of blobs or irregular fragments into the host magma presumably as a consequence of forced convection inside the chamber. In this contribution, we analyse a particular case of an intrusion of basaltic magma into a granitic magma chamber from Gerena in the Variscan basement of SW Spain. At the moment of the intrusion both magmas behaved as liquids, but the degree of crystallinity changed drastically in both magmas at thermal equilibrium due to their contrasted compositions. At equilibrium, the crystal content of the granitic magma can be < 50 vol%, and >80 vol% for the basaltic one. Morphological, textural and mineralogical evidences show that at the stages immediately after the intrusion, the basaltic magma was preserved as a single mass limited by a thin and solid chilled margin, probably at the bottom of the granitic magma. Chilling caused massive crystallisation of plagioclase and oversaturation of the basaltic magma (second boiling) in dissolved fluids (CO2, H2O, etc.), which started to form bubbles. A progressive increase of gas pressure in the crystallizing basaltic magma favoured bubble size increase and coalescence, which resulted in an explosive disruption of the quasi-solid basaltic magma into the surrounding granitic magma, generating a large variety of blocks with morphologies similar to those of pyroclastic fragments. This implies that compressibility of granitic magma at that stage of crystallisation was low enough to allow basaltic magma to expand explosively and the resulting fragments to travel distances from several centimetres to metres inside the composite magma chamber. Further movement of the granitic magma, probably associated with convection, caused additional displacements of the basaltic fragments. The increase of magma pressure derived from the intrusion, oversaturation and explosion of basaltic magma, was not sufficient to trigger an eruption in the studied case.