The making of porphyritic andesites at Volcán de Colima

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A recent increasing trend in the intensity of the activity at Volcán de Colima, Mexico, has led to certain anxiety and the need for more insight into the dynamics of the magmatic system and the cyclicity of larger eruptions. The magmas erupted since 1998 show limited variations in bulk rock (59-61.4 wt% SiO_2) and mineral compositions, as well as U-series disequilibria, indicating that the magmas reaching the subvolcanic magmatic system are homogenous in composition and have similar overall residence times in the crust (most likely <3 kyr). Variations in ^{210}Pb-^{226}Ra disequilibria nevertheless demonstrate that the vapour-saturated section of the magmatic system comprises multiple magma batches characterised by variable degassing timescales (between less than a few months and 11 years).

The melt inclusions indicate that the predominant oscillatory zoned phenocrysts (19-27 vol%) formed in the vapour-saturated system at pressures <1.5 kbar. Major and trace element variations across the plagioclase phenocrysts rule out closed system crystallization of the degassing magmas, and indicate repetitive influxes of monotonous intermediate melts. Furthermore, the bulk composition of the groundmasses are more mafic then anticipated from the melt inclusion compositions and imply that the melts that eventually carried the phenocrysts to the surface did not differentiate appreciably during their ascent trough the vapour-saturated section of the magmatic system.

It appears that, on the decadal timescale, the melt composition in the subvolcanic magmatic system is essentially buffered by repetitive influx of monotonous intermediate melts and that the differentiation trend recorded by the melt inclusions represents negligible volumes of melt. Variable melt fluxes through the vapour-saturated section of the magmatic system and decoupling between the melt and crystal ascent rates are likely to be a key process to form the porphyritic andesites. Taking into account the ^{226}Ra-^{230}Th crystal ages, it is nevertheless conceivable that the phenocrysts and melts residence times in the vapour-saturated section of the magmatic system are of the same order of magnitude (months to years). Cannibalisation of mafic crystals (10 vol%) left behind by previous phases of activity is an additional ubiquitous process in the petrogenesis of these andesites.