Propagation of a magmatic solidification front in a partially eroded magma chamber floor

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Shortly after the recognition that *in situ* crystallization may be an important process in magmatic chambers, igneous petrologists have adopted the term "solidification front" to refer to the region located at the margins of a magma chamber where crystallization is thought to take place. Solidification fronts are generally envisioned to propagate unidirectionally towards the centre of the chamber where they may meet to form a sandwhich horizon. However, if crystallization is interrupted by occasional magma replenishments in an open system, the floor and/or roof cumulates may experience intense thermo-chemical erosion, resulting in a highly irregular platform for further growth of the solidification front. These irregularities manifest as undulations and depressions in the magma chamber floor, as well as complex, three-dimensional frameworks of interconnected footwall fragments that appear as *in situ* autoliths in the overlying lithology. We seek to understand how a solidification front may propagate in the presence of a highly irregular, partially eroded magma chamber floor.

Massive magnetitite layers of the Bushveld Complex are the ideal rock types for this study for two reasons: (1) They are frequently underlain by anorthositic footwall rocks that have been affected by thermo-chemical erosion and (2) they are chemically sensitive enough to record the propagation of the solidification front on a sub-decimetre scale due to the extremely high compatibility of Cr into magnetite. We map the two-dimensional distribution of Cr in one magnetitite layer that has an irregular basal contact and contains numerous anorthosite autoliths. We show that magnetite nucleates and grows directly on the footwall anorthosites and on the outer surface of in situ autoliths. This results in a multi-directional propagation pattern of the solidification front from the floor upwards and also sideways and downwards from the outer surfaces of anorthosite autoliths. Multiple mini sandwhich horizons result in the vicinity of the magma chamber floor where solidifcations fronts meet. Our study thus brings to light a new petrological phenomenon: the multi-directional propagation of the solidification front in a partially eroded magma chamber floor.