Physical behaviour of plagioclase in basaltic melts: Experiments at 1220°C, 0.5 GPa and 1000G

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Understanding the physical behaviour of plagioclase in basaltic liquids is crucial to anorthosite formation, layered mafic intrusions, to the final stages of planetary magma oceans and more general to fractional crystallization.

This study investigates plagioclase settling and compaction following previous work on the formation of olivine and chromite cumulates [1],[2]. Statically annealed equilibrium experiments with different plagioclase/melt proportions were conducted at 0.5 GPa, 1190-1230°C and centrifuged with accelerations between 700 and 1000 *g* in a minimized single stage centrifuging piston cylinder apparatus. The starting melt composition was an experimentally derived dry tholeiitic basalt composition evolved from a primitive basalt in equilibrium with a lherzolite [3] and represents the melt composition at the onset of plagioclase crystallization. This composition was mixed in weight proportions of 7:3 and 9:1 with natural plagioclase seeds of appropriate composition (An_{70-80}) and well defined size populations.
Image analysis of the run products provides values for porosity, grain size and size distribution of plagioclase grains in the experimental charges.

The conducted experiments show that An-rich plagioclase effectively sink in tholeiitic basalts with velocities that are 1-2 orders of magnitude smaller than those of olivine and chromite [1],[2]. Gravitational settling appears to sort grains also for shape, the more platy crystals clearly dragging behind. Errors are large on the calculation of the density contrast, taken at face value, plagioclase sinks 15 times slower in the experiments than the calculated Stokes velocity. Gravitational settling leads to an orthocumulate layer with a porosity of 0.63±0.03, significantly less than the 0.52 for chromite and 0.54 for olivine cumulates [1],[2].
Several experiments were run with up to 50 hours of centrifugation at 1000 *g*. Gravitationally driven compaction of the plagioclase pile were found to be minimal, but further experiments are required to precisely determine the compaction rate.

[1] Schmidt et al. (2012) CMP 164, 959-976, [2] Manoochehri and Schmidt (2014) CMP 168, 1091, [3] Villiger et al. (2007) J Pet 48, 159-184