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Crystallization and initial mush porosity of poikilitic anorthosites in the Bushveld Complex

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Cumulates in large layered intrusions are the products of numerous processes, including primary crystal accumulation, compaction, dissolution, melt migration and textural coarsening. Understanding and quantifying the relative importance of each process is difficult because of considerable textural [1] and chemical [2] re-equilibration, due to slow cooling.

Anorthosites in the Bushveld Complex are commonly characterized by a distinctive poikilitic texture (Fig. 1), colloquially termed 'mottled' and 'spotted' anorthosites [3], defined by pyroxene oikocrysts that are hosted in an anorthosite matrix. Pyroxene oikocrysts enclose a population of plagioclase chadacrysts. Mottled oikocrysts are skeletal and do not appear to be cumulus. Spotted oikocrysts are euhedral and are partly overgrown by skeletal pyroxene, suggesting they are mostly cumulus in origin. Pyroxene oikocrysts therefore provide a window into the primary crystal framework of these anorthosites. We conducted a textural quantification study of the mottled and spotted anorthosites from the UG-2 cyclic unit to understand how this rock type crystallized.

Figure 1: Poikilitic anorthosites exposed at Tweefontein (Eastern Bushveld). Note that oikocryst size populations locally define igneous layering.

Crystal size distribution (CSD) data reveals a progressive increase in the abundance of larger crystals from oikocryst to matrix. Spotted oikocrysts enclose a population of fine-grained plagioclase chadacrysts, whereas the anorthosite matrix preserves a population of larger plagioclase crystal sizes. This is attributed to post-cumulus textural coarsening of the anorthosite matrix, emphasized by a counter-clockwise rotation of the model CSD curve. Mottled oikocrysts enclose a plagioclase crystal population that is intermediate between spotted oikocrysts and the anorthosite matrix.

Populations of plagioclase chadacrysts within spotted oikocrysts suggest that the initial mush porosity may have been as high as *ca.* 75% (averaging *ca.* 55%). Initial mush porosity estimates calculated from mottled oikocrysts are lower (averaging *ca.* 35%), suggesting that mottled oikocrysts crystallized later than spotted oikocrysts, consistent with the morphologies of both types of oikocryst.

This textural study of poikilitic anorthosites provides insights into both magma crystallization dynamics and post-cumulus processes in the Bushveld Complex. Constraints provided by plagioclase crystal populations suggest that the anorthositic mush had high initial mush porosity. A stable crystal framework was potentially developed at crystallinity values as low as *ca.* 25%.

References:

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