Basal olivine-rich zones in sills: slurry injection vs. crystal settling; static vs. dynamic re-equilibration.

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Basal, olivine-rich zones, found in many tholeiitic sills or lavas, can form by the post-emplacement injection of olivine-rich slurry into a pre-existing magma body, or by the settling of phenocrysts from a relatively homogeneous, phenocryst-phyric, initial magma. Basal olivine-rich zones in sills exposed on Victoria Island, NWT, Canada, contain well-developed trends of progressively increasing olivine mode and grain-size, and decreasing Mg# upward from the base, suggesting formation by crystal settling within an initial phenocryst-phyric magma. The basal olivine-rich zone in the Palisades sill, NJ, contains more complex variations in olivine mode, grain-size, and Mg#, suggesting formation by emplacement of one or more pulses of olivine-rich slurry. Although there is no systematic upward trend in modal olivine abundance in the basal olivine-zone of the Palisades sill, there is a positive correlation between olivine mode and Mg#. The previously described “trapped liquid shift effect”, reported from a number of locations, results in a larger shift to more Fe-rich olivine compositions in samples with low olivine abundances, and a smaller shift in samples with high olivine abundances. The “trapped liquid shift effect” is misnamed because, in some cases the olivine is likely to be re-equilibrating with interstitial liquid that is not “trapped” in the rock, but rather with liquid that is migrating through a crystal-liquid mush during compaction. We prefer to use “static re-equilibration” because it occurs after the olivine has accumulated in a crystal mush zone adjacent to the sill margin. Three olivine-rich zones in Victoria Island sills contain the opposite re-equilibration trend, suggesting “dynamic re-equilibration” during settling of initial olivine phenocrysts. Olivine at the top of the zones, where it is the most abundant, settled the farthest, was exposed to the most magma, and is the most re-equilibrated (lowest Mg#).