

Abstract

Texture of igneous rocks, which includes size, shape and spatial distribution of grains, represents the final record of kinetic and mechanical processes operating during ascent and final emplacement of a magma. However, traditional geochemical approaches cannot assess and verify the physical processes of magma solidification, in particular, crystal nucleation and growth, textural coarsening, or mechanical crystal-melt interactions. In this work, I apply stereological methods to quantitatively characterize the textures and to interpret the crystallization history of granitic rocks in the Western Krušné hory/Erzgebirge and Vogtland. The Western Krušné hory/Erzgebirge granites consist of three suites: biotite granites (Kirchberg), muscovite-biotite microgranites (Walfischkopf), and topaz-zinnwaldite alkali-feldspar granites (Eibenstock), which consist of eight intrusive units and two aplite dyke sets. The entire granite sequence exhibits an extreme and nearly continuous differentiation range, but in detail the evolutionary trends of each suite are independent, and individual intrusive units are also clearly compositionally separated. The granites consist of 29-43 vol.% quartz, 20-30 vol. % plagioclase, 22-31 vol. % K-feldspar, 2-9 vol. % biotite, <2 vol. % muscovite, and minor topaz and apatite. All samples approach minimum (or eutectic) proportions of quartz, plagioclase and K-feldspar, hence they initially represent crystal-free liquids or modal cumulates (i.e., with eutectic phase proportions), or mixtures of both. Modal composition of individual grain-size fractions is variable, but it does not indicate selective entrapment of some minerals or their sequential crystallization. In the Kirchberg and Eibestock suites, the textural evolution follows identical trends, from seriate coarse-grained varieties to equigranular fine-grained types. The log-linear crystal-size distribution histograms are remarkably curved (concave-up) for the coarse-grained textures and become straight as overall grain size decreases. Felsic minerals have non-random distribution and are clustered, and their content ratios indicate preferential self-aggregation. These observations are consistent with substantial enrichment in large crystals in the coarse-grained granites, minor enrichment in the medium-grained types, and a single-step crystallization history of the fine-grained granites, independently of the degree of chemical differentiation. Most samples and their minerals record substantial crystal depletion in the very small size fractions, previously interpreted as resulting from Ostwald ripening, but recently reproduced in single-step crystallization experiments and high-resolution numerical simulations. Similarly, the overall crystal size distribution in the coarse-grained varieties does not support widespread melt-assisted or subsolidus coarsening. The concave-up crystal size distributions and the presence

of excess large crystals in the progressively coarse-grained samples are consistent with mechanical accumulation (settling) or extraction of the interstitial melt. In such a scenario, the less evolved coarse-grained granites would represent mechanical cumulates or residual crystal framework, and this mechanism would explain the apparently extreme range of chemical fractionation by inherent difference between residual melts and cumulate-dominated rocks.