American Mineralogist, Volume 97, pages 1049–1059, 2012

Vertical zonation of the Barcroft granodiorite, White Mountains, California: Implications for magmatic processes

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Abstract

Petrological and geochemical variations within plutons reflect their magmatic and emplacement histories. Here we present new magnetic susceptibility (K_m) data on the ~163 Ma Barcroft granodiorite pluton in eastern California, which is exceptionally well exposed, especially in the vertical dimension. The Barcroft pluton offers exposures over a total of 2560 m of elevation and is an appropriate target to investigate variations of magnetic susceptibility. In ferromagnetic plutonic rocks, K_m reflects mainly the abundance of magnetite, whereas in paramagnetic plutonic rocks it reflects primarily the abundance of mafic silicates. Magnetic susceptibility is also determined by magmatic processes such as crystal fractionation and by intensive parameters such as oxygen fugacity. Other magmatic processes, including magma replenishment, hybridization, and host-rock assimilation, may also influence K_m variations. A first data set is based on 622 core samples that were measured in the laboratory. Our second data set comes from 1960 field measurements collected at 196 stations between ~1600 and 4000 m elevation. Detailed surveys were performed at the outcrop scale to evaluate the impact of the ~100 Ma McAfee Creek intrusion on the Barcroft background magnetic susceptibility. The combined data sets display a broad positive correlation between K_m and elevation. Pluton mineralogy also appears to vary with elevation but is more difficult to quantify. At the outcrop scale, small dikes of the McAfee Creek granite transect the pluton and are responsible for a decrease in K_m of the host granodioritic rocks toward the dikes due to late-stage magmatic or hydrothermal alteration. A contour map of K_m shows a high degree of correlation with local topographic features such as deep canyons. Magnetic susceptibility of the Barcroft mafic rocks varies at the outcrop scale as a result of presence of petrological heterogeneities. However, these small-scale variations are embedded in a broader magnetic susceptibility trend due primarily to elevation, which reflects petrologic stratification of the pluton. The late-magmatic and hydrothermal alterations described in previous studies do not affect the spatial distribution of magnetic susceptibility. We propose that vertical increase of K_m was primarily caused by crystal fractionation or another magmatic differentiation mechanism rather than by an externally driven increase in oxygen fugacity toward the roof of the intrusion.

Keywords: Magnetic susceptibility, granodiorite, pluton, zonation, iron oxides