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Igneous or metamorphic? Hornblende phenocrysts as greenschist facies reaction cells in the Half Dome Granodiorite, California

Stephen C. Challener[1,†] and Allen F. Glazner[1,*]

[1]Department of Geological Sciences, University of North Carolina, Chapel Hill, North Carolina 27599-3315, U.S.A.

Abstract

The Half Dome Granodiorite, Yosemite National Park, California, is recognized in the field by euhedral, fresh-looking, black hornblende phenocrysts up to 2 cm in length. This variety of granodiorite typifies intermediate-age hornblende-phyric units of Cretaceous nested plutonic suites in the Sierra Nevada batholith. Although only inclusions of feldspar are evident in hand samples, the phenocrysts are riddled with up to 50% inclusions of every major mineral found in the host granodiorite plus metamorphic minerals formed during cooling. Amphibole compositions within single phenocrysts vary from actinolite with less than 1 wt% Al_2O_3 to magnesiohornblende with over 8 wt%. Elemental zoning within the amphibole is highly irregular on the micrometer scale, showing patches and polygonal zones with dramatically different compositions separated by sharp to gradual transitions. The chemical compositions of entire phenocrysts are equivalent to hornblende plus a small proportion of biotite, suggesting that the non-biotite inclusions are the result of metamorphism of the phenocrysts. Backscattered electron imaging shows evidence of brecciation that may have been the result of volume changes as hornblende was converted to actinolite. Pressure calculations using the Al-in-hornblende barometer show unreasonably wide variations on the micrometer scale that cannot have been produced by temperature or pressure variations during crystallization. These hornblende phenocrysts would thus be unsuitable for geobarometry, and caution must be used to avoid similarly zoned phenocrysts in the application of the Al-in-hornblende geobarometer.

Keywords: Igneous petrology, amphibole, mineralogy, metamorphic petrology, incremental emplacement, barometry, hornblende, thermal cycling