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Reversely zoned plagioclase in lower crustal meta-anorthosites: An indicator of multistage fracturing and metamorphism in the lower crust

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Abstract

This paper describes the formation mechanism of reversely zoned plagioclase, which has been observed frequently in lower crustal shear zones and is indicative of multistage fracturing and metamorphism in the lower crust, by studying the microstructural and chemical characteristics of plagioclase in sparsely fractured anorthosites and anorthositic mylonites from the Eidsfjord shear zone, Langøya, northern Norway. Based on the field relationship between sparsely fractured anorthosite and anorthositic mylonite, the fracturing of anorthosite occurred before the formation of mylonite. In sparsely fractured anorthosites, transgranular fractures are observed; hydration-reaction products, including Na-rich plagioclase, occur within cracks and fractures, suggesting that hydration reactions occurred during or after fracturing. The hydration reactions in sparsely fractured anorthosites are estimated to have occurred at higher-pressure (*P*) amphibolite-facies conditions (~0.9–1.0 GPa and ~550–700 °C). In anorthositic mylonites, which are considered to have initiated by fracturing and subsequent hydration metamorphism at lower-*P* amphibolite-facies conditions (~0.7 GPa and ~600 °C), recrystallized plagioclase grains often show compositional zoning with an Na-rich core and a Ca-rich rim. Because the compositions of metamorphic plagioclase grains in the sparsely fractured anorthosites and those of the Na-rich cores of the reversely zoned plagioclase in anorthositic mylonites are similar to each other, the Na-rich cores of the matrix plagioclase in the anorthositic mylonites have recrystallized under higher-*P* amphibolite-facies conditions and then been overgrown or replaced by the Ca-rich rims under lower-*P* conditions. Consequently, the reversely zoned plagioclase observed frequently in lower crustal shear zones is an indicator of multistage brittle fracturing and subsequent hydration metamorphism during exhumation, providing information relevant to understanding the deep rupture process caused by repeated seismicity alternating with aseismic creep below the seismogenic zone.

Keywords: Anorthositic mylonite, plagioclase, chemical zoning, oxygen isotopic composition, fracturing, lower crust