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Study on structure variations of incommensurately modulated labradorite feldspars with different cooling histories

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ABSTRACT

The incommensurately modulated structures of three intermediate plagioclase feldspars with compositions of ~An_{51} are determined by single-crystal X-ray diffraction analyses. The samples selected cover a range of different cooling rate, from relatively fast to extremely slow. The structures show various ordering states that are directly correlated with the cooling histories of the samples. The slowest cooled sample shows an *e*1 structure with strong density modulation, along with nanoscale exsolution lamellae. The fastest cooled sample displays an *e*2 structure, without second-order satellite reflections (*f*-reflections) and density modulation. The sample with intermediate cooling rate shows a less ordered *e*1 structure with weak density modulation, but the modulation period and orientation are the same as in *e*2 structure. The comparison of the structures with the same composition reveals the ordering process and phase transitions during the cooling of plagioclase within the compositional range of Bøggild intergrowth. New parameters from modulation waves can be used for quantifying the ordering state of plagioclase feldspars. Proposed phase relationship and T-T-T diagram for ~An_{51} plagioclase feldspars are illustrated for explaining the relationship among $C\bar{1}$, *e*1 and *e*2 structures, and relative cooling rates of their host rocks.

Keywords: Labradorite, incommensurate, modulated structure, density modulation, gabbro, *e*-plagioclase, cooling rate, ordering state, exsolution lamellae, intermediate plagioclase