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Non-periodic fluctuations of the displacive order parameter and phase transitions in pyroxene and plagioclase

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The $I\bar{1} - P\bar{1}$ and $C2/c - P2_1/c$ displacive phase transitions in Ca-rich plagioclase and pigeonitic pyroxenes, respectively, produce antiphase domains (APDs) in the low-temperature phases. The observed APDs are either large, with sharp, ribbon-like, boundaries and can be characterized by a uniform order parameter within the domains or small without clearly defined boundaries. For such samples the order parameter changes continuously from place to place. Recent high-resolution transmission electron microscopy (HRTEM) observations of Ca-rich plagioclase suggest that these boundaries originate from fluctuations in the order parameter for the displacive low-temperature $I\bar{1} - P\bar{1}$ phase transition (Nèmeth et al. 2007). The fluctuations are non-periodic, and diffuse elongated reflections occur in diffraction patterns. In contrast, sharp reflections appear for samples having large APDs. The non-periodic fluctuations in minerals can be interpreted as the results of compositional or crystallographic heterogeneities. Although compositional heterogeneities probably promote the formation of non-periodic fluctuations, such fluctuations are also observed in synthetic Na-free anorthite.

Non-periodic fluctuations originate in a low-strain regime and can be observed at room temperature for compositions close to bytownite or subcalcic augite.

The non-periodic structure, which occurs between the low- and high-temperature phases, significantly affects the phase transition behavior. The analysis of IR spec-

tra in anorthite (Atkinson et al. 1999) and in situ high-temperature TEM observation of plagioclase and pigeonite (Tribaudino 2000) suggest that samples affected by non-periodic fluctuations are structurally intermediate between the high- and low-symmetry phases.

References

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