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Morphology and microstructure of magnetite and ilmenite inclusions in plagioclase from Adirondack anorthositic gneiss

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Abstract

It is well known that oriented iron and titanium oxide inclusions occur in pyroxenes and plagioclase of anorthosites and granulites, and they are attributed to exsolution at subsolidus conditions. The oxides occur as needles or platelets. In this study, we determine the morphology of oxide needles as well as their orientation in plagioclase (An 30–35) in anorthosite gneiss from the Adirondack mountains (New York). The investigation was done with electron backscatter diffraction (EBSD) in a scanning electron microscope, as well as Laue diffraction with a microfocus synchrotron X-ray beam at the Advanced Light Source in Berkeley. It was observed that the needle direction is [110] in magnetite and [10$\bar{1}$0] in ilmenite. The needle direction is consistently parallel to [001] of plagioclase. Furthermore, (111) of magnetite and (0001) of ilmenite are sub-parallel to (120) and ($\bar{1}$20) of plagioclase. We note that for directions [110] in the magnetite structure and [10$\bar{1}$0] in ilmenite, O atoms are close-packed, and (111) and (0001) are close-packed planes, correspondingly. In plagioclase, [001] is a direction with open channels as well as approximate alignment of Si tetrahedral edges, thus providing nucleation sites with a coincidence lattice relationship. (120) and ($\bar{1}$20) in this triclinic mineral are planes with approximate tetrahedral sides so that the relationship is structurally plausible. From Laue diffraction, we can determine that the magnetite needle axis is subject to an extensional stress, most likely attained during cooling of the inclusions within the plagioclase host.

Keywords: Plagioclase, magnetite needles, ilmenite needles, orientation of inclusions, residual stress