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Subsolidus breakdown of armalcolite: Constraints on thermal effects during shock lithification of lunar regolith

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Abstract

Shock lithification of regolith breccias is a ubiquitous process on the surfaces of airless planetary bodies and may induce thermal effects, including melting on regolith breccia minerals. However, potential thermal effects on lithic and mineral clasts in regolith breccias have seldom been quantitatively constrained. Here, we report two types of micro-textures of armalcolite [$(Mg,Fe^{2+})Ti_2O_5$] in an Mg-suite lithic clast from lunar regolith breccia meteorite Northwest Africa 8182. One type of armalcolite contains oriented fine-grained ilmenite grains; the other occurs as an aggregate of ilmenite, rutile, spinel, and loveringite. We propose that the two types of micro-textures formed through subsolidus breakdown of armalcolite by different processes. The formation of ilmenite inclusions in armalcolite is related to slow cooling after the solidification of its source rock, whereas the ilmenite-rutile-spinel-loveringite aggregates probably formed during the shock lithification event of NWA 8182. The results indicate that the temperature at the margin of lithic clasts could be raised up to at least 600 °C during strong shock lithification of lunar regolith and has profound thermal effects on the mineralogical and isotopic behaviors of lithic and mineral fragments in lunar regolith breccias.

Keywords: Armalcolite, subsolidus breakdown, shock lithification, lunar regolith, lunar meteorite