Evaluating the influence of spodumene grade and crystal grain characteristics on the UCS of pegmatite

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# ABSTRACT

As global lithium demand grows, spodumene-bearing pegmatites have become critical feed sources for battery mineral supply. However, the influence of spodumene’s mineralogical characteristics— particularly grade, grain size, and crystal orientation—on the uniaxial compressive strength (UCS) of pegmatite remains poorly understood. Current geotechnical models often simplify pegmatites as isotropic, despite the coarse, anisotropic nature of spodumene crystals, which can significantly affect rock strength. This study investigates the relationship between UCS and spodumene characteristics through integrated mineralogical and mechanical testing. A set of drill core samples was prepared to meet ISRM and ASTM standards, with each specimen characterised for spodumene content, grain size, and orientation relative to the loading axis. UCS testing was conducted under controlled loading conditions, and failure modes were analysed post-testing. The working hypothesis is that higher spodumene content and crystals aligned parallel to the loading direction will increase UCS, due to spodumene’s high strength and prismatic habit, which may enhance load-bearing continuity. Mineralogical data and UCS results are assessed through regression analysis, with crystal orientation patterns classified as either uniform or non-uniform to evaluate potential anisotropic effects. Samples will also undergo chemical assay to explore the relationship between lithia grade and mechanical behaviour. By linking geometallurgical and geomechanical properties, this research provides a more nuanced understanding of the strength behaviour of spodumene-rich pegmatites. The findings have practical implications for improving drill and blast design, refining geotechnical block models, and optimising processing strategies in hard rock lithium operations.