

Damage evolution and acoustic emission characteristics of hard rock under high-temperature thermal cycles

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Abstract: Understanding the mechanical properties of rock under high-temperature thermal cycles is crucial for deep geotechnical engineering construction. This study investigated the mechanical properties and fracture evolution characteristics of Beishan granite after exposure to different temperatures ranging from 25-800°C, as well as thermal cycles, through multiple experiments. The results indicate that the tensile strength (σ_t) decreases with increasing temperature and thermal cycles. Incremental temperatures result in more active AE events, while AE cumulative events decrease during thermal cycles. The b-value exhibits higher fluctuations at $T \leq 400^\circ\text{C}$. At $T \geq 600^\circ\text{C}$, the b-value decreases before failure and maintains small dramatic fluctuations, then fluctuates upward in the post-peak failure stage, indicating a transition from brittle failure to plastic failure in rock behavior. The proportion of shear cracks substantially increases with temperature and thermal cycles. Additionally, It is observed that the damage variable (DAE) increases with temperature under constant stress condition. Physical and chemical reactions within granite at high temperatures lead to initiation, development, and connectivity of numerous microcracks, particularly at $T \geq 600^\circ\text{C}$. Cyclic heating generates alternating thermal stress which further promotes an increase in propagation of microcracks, exacerbating damage to granite.

Keywords: Granite; High temperature thermal cycle; Acoustic emission; b-value; RA-AF; Thermal damage