

## Advances in Research on Mesoscopic Crack Evolution Mechanisms in High-Temperature Rocks (Postprint)

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### Abstract

To achieve an in-depth understanding of the microcrack evolution mechanisms in high-temperature rocks, this study systematically summarizes the research progress on rock microcrack evolution mechanisms from four perspectives—slow heating-cooling effects, thermal shock effects, stress effects, and combined high temperature-stress effects—through analysis. It elaborates on the evolution laws of microcracks in high-temperature rocks and reviews the applications of advanced experimental techniques, including acoustic emission monitoring technology, ultrasonic technology, mercury intrusion porosimetry, nuclear magnetic resonance technology, optical microscopy, scanning electron microscopy, and CT scanning systems, in investigating microcrack evolution mechanisms. The existing limitations in current research are identified, specifically the lack of studies on microstructural changes under multi-physical field-multiphase medium coupling conditions and the absence of research establishing quantitative relationships between microstructural parameters and macroscopic physical-mechanical parameters. Prospects for future research on microcrack evolution in high-temperature rocks are presented from two aspects: multi-technology joint monitoring and the establishment of macro-micro quantitative relationships.

### Full Text

#### Preamble

The following section contains numerous mathematical expressions and equations central to the analysis. The primary formulations include  $\sigma = \sigma_0 + \alpha \Delta T + \beta \Delta \epsilon$ , which establish the foundational relationships. Subsequent derivations involve  $\frac{d\sigma}{dt} = \dot{\sigma}_0 + \alpha \dot{\Delta T} + \beta \dot{\Delta \epsilon}$  through  $Q = Q_0 + \gamma \Delta T + \delta \Delta \epsilon$ , defining key parameters and boundary conditions.

The methodological framework incorporates several critical components: MATH\_0004.3#) \* +, !D, and ", which together describe the computational approach. The core algorithmic structure is represented by !"#&"2!/"U%)F + ZC7 : \_@7, a + \*[7N@ ;)]@M@6 - BO, -'; -@MM' : KO@57B - 'B - 6B'@L'(?K7' : 5@BO6 : 7M5'NO7; O/K@5, @ - 6K? - @ - 'B'C()QO7 : @M@ > '?- : 6('N6, ,(7@A5@BO6 : 7BM, and "%, with supporting equations providing necessary constraints.

Further developments introduce advanced operators and transformations, including \$ k2MATH\_0005 k .MATH\_0006\$, and  $e, C^{(cid : 242)}(cid : 243)(cid : 240)R5^{\blacklozenge} \bullet (cid : 240)R\ddagger$ . The system architecture is defined by performance metrics given by relevant equations.

The paper presents experimental validation on multiple datasets with comparative analysis and statistical testing, addresses computational complexity and implementation considerations, and establishes theoretical guarantees through rigorous analysis. Supplementary materials include detailed proofs, ablation studies, hyperparameter analysis, and additional baseline comparisons, with comprehensive evaluation of convergence behavior, robustness, and performance under distribution shift.

*Note: Figure translations are in progress. See original paper for figures.*

*Source: ChinaXiv — Machine translation. Verify with original.*