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基于细观结构表征的岩石破裂热－力耦合模型及应用

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MESO-STRUCTURE CHARACTERIZATION BASED ON COUPLED THERMAL-MECHANICAL MODEL FOR ROCK FAILURE PROCESS AND APPLICATIONS

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摘要 参考文献 相关文章

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摘要 岩石热破裂的研究只有考虑各种矿物组分造成的岩石的非均匀性，才能更客观地反映岩石热破裂的本质。利用数字图像处理技术数字化表征岩石内部矿物颗粒的几何形态，充分考虑岩石真实的细观结构，结合细观损伤力学和热弹性理论，建立能更客观的分析岩石热－力耦合作用下破裂过程的数值模型。以花岗岩为例，运用数值模型研究花岗岩在温度和压缩荷载共同作用下的力学行为和破裂过程。研究结果表明，温度对岩石的力学性质和破裂演化过程影响显著，热破裂裂纹多发生在矿物颗粒边界处，并沿颗粒边界扩展，局部会形成闭合多边形，其热破裂演化过程与试验结果基本相符，从而验证了数值模型的合理性和有效性，该数值模型为细观尺度定量研究岩石热破裂提供一种新的方法。

关键词： 岩石力学；数字图像；细观结构；热破裂；热&ndash 力耦合模型；花岗岩

Abstract： The heterogeneity of rock contributed by the geometry and properties of mineral constituent should be taken into account in the study of rock thermal cracking，which aids to understand the thermal cracking mechanism more objectively. This paper presents a coupled thermal-mechanical numerical model for rock failure based on meso-structure characterization. The model，based on thermoelastic theory and microscopic damage mechanics，employs digital image processing technologies to identify mineral grains and characterize their geometries in order to consider the effect of real meso-structure of rock. Taking granite for example，mechanical behaviors and fracturing process of granite under combined thermal and compressive loading condition are investigated. The results show that the temperature has a great influence on rock properties and damage evolution. The initiations of the cracks induced by thermal stress locate at the boundaries between minerals；and then the cracks propagate along the boundaries. Local cracks may be closed to form a polygon. The simulated results are in agreement with the experimental results，which validates the model. It provides a new tool to study the mechanism of rock thermal fracturing at meso-scale level.

Keywords： rock mechanics digital image meso-structure thermal fracturing coupled thermal-mechanical model granite

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