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# 岩石细观结构量化试验研究

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摘要　岩石是一种多尺度材料，以往的研究大多是在宏观尺度下进行的，由于岩石在外部荷载作用下的断裂乃至破坏是由于处于细观尺度的微裂隙的增长和贯通引起的，所以对处于细观尺度的微裂隙进行量化分析，对于了解和研究岩石的力学性质有一定的意义。首先，基于损伤理论建立一套岩石细观量化试验方法，利用扫描电镜对四川锦屏大理岩进行观测，得到大量岩石细观结构图片。基于数字图像处理理论，利用区域生长算法对图片进行处理，并编制相关程序实现图像增强和图像分割，从分割后的二值化图像中提取微裂隙的长度、方位角、宽度、面积和周长等细观信息。然后，利用统计学理论对获取到的微裂隙细观信息进行统计分析，得到各参数的统计规律，进一步利用Monte Carlo理论模拟岩石细观结构体积表征单元。最后，依据几何损伤理论得到岩石细观结构体积表征单元的初始损伤张量，将其引入到G. Swoboda的损伤理论中，模拟得到单轴压缩试验和常规三轴压缩试验的应力－应变关系，并与实际试验的结果进行比较。结果显示可以较准确模拟2种力学状态下的应力－应变关系。

关键词　岩石力学；大理岩；岩石细观结构；量化；扫描电镜；图像处理；损伤

分类号



# QUANTITATIVE TEST STUDY ON MESOSTRUCTURE OF ROCK

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**Abstract**

Rock is a multiscale material，and in the past，the research of rock in macroscopic scale is much more than that in mesoscale. But the damage and failure of rock under loading are caused by the propagation and coalescent of cracks at mesoscale，so it is helpful to understand the mechanical behaviours of rock by quantitatively investigating on mesostructure of rocks. The quantitative test on mesostructure of rock is designed based on damage mechanics. A great deal of mesostructural images of Jinping marble in Sichuan Province have been obtained by means of scanning electron microscopy(SEM). The mesostructural images of marble are processed by regional growing theory based on image processing technique. According to stereology theory，the program is compiled by MATLAB to enhance the details of images and execute the image segmentation. The mesostructural information of rock microcracks such as length，angle，width，area，perimeter，etc. are obtained from binary images after segmentation. Then，the

mesostructural information of microcracks is analyzed by statistical theory and the distribution regularities of microcrack parameters are proposed. Based on the statistical regularities of the mesostructural parameters，the representative element volume(REV) of rock in mesoscale is simulated by using the Monte Carlo theory. Finally，the initial damage tensor of REV of rock in mesoscale is obtained according to the geometrical damage mechanics；and it is used in the G. Swoboda damage model to obtain the stress-strain relations under the conditions of uniaxial and triaxial compression loads. By comparing the simulated result with the actual experiment result of stress-strain relationships，it shows that the simulation of two conditions nicely agree with in-situ test results.

**Key words** rock mechanics；marble；rock mesostructure；quantification；scanning electron microscopy(SEM)；image processing；damage

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