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# Direct Measurement of Fracture Roughness and Spectral Analysis of Roughness Geometry

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ABSTRACT

The fracture roughness of rock specimens is observed by a new confocal laser scanning microscope (CLSM; Olympus OLS1100). The wavelength of the laser is 488nm and laser scanning is managed by a light polarization method using two galvano-meter scanner mirrors. The function of laser reflection auto-focusing enables line data to be measured rapidly and precisely. The system improves the resolution in the light axis (namely z) direction because of the confocal optics. It is possible to measure a specimen of up to 10cm x 10cm in size when fixed on a specially designed stage. Sampling is managed with a 2.5 μm spacing along the x and y directions. The highest measurement resolution in the z direction is 0.05μm, which is more accurate than other methods.

Core specimens of coarse and fine grained granites were provided and fractures were artificially induced by a Brazilian test method. Measurements were performed along three scan lines on each fracture surface. The measured data were represented as 2-D and 3-D digital images showing detailed features of roughness. Line profiles of the coarse granites showed more changes of undulation than those of the fine granite. Spectral analyses by the fast Fourier transform (FFT) were performed to characterize the roughness data quantitatively and to identify influential frequency of roughness. The FFT results show that components of low frequencies are dominant in the fracture roughness. This study also verifies that spectral analysis is a good approach to understand complicated characteristics of fracture roughness. One of the ultimate objectives of the study was to suggest a methodology to select effective frequencies among the constituent frequencies of roughness as measured with very accurate

measurement equipment. The other objective was to perform reconstruction of roughness with noise filtering which will be applied as input data to a fracture model for a numerical analysis.

Key words: Fracture roughness, Confocal laser scanning microscope, Parzen window, FFT spectral analysis, Reconstruction of roughness