Application of Photogrammetry in Geology: 3D Investigation of Rock Fracture Distributions *Poster*

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Geology as a science has an important visual component and the knowledge of any geologist is deeply linked to visual experience of rock outcrops, thin sections and analytical images. One of the shortcomings of most geological images such as maps, cross sections and outcrop photographs is that they are 2D, while processes geologists are interested in are typically occurring in 3D space. The 3D geometry of faults, fractures and joints is crucial to quantify geological processes related to fracture mechanics, such as hydrothermal mineralization and ground water flow, but also geotechnical problems such as rock mass stability. A number of studies have shown that some geological structures can be described with a scale invariant, fractal distribution. So far these observations on which these findings are based were restricted to one and two dimensions and has been difficult to obtain a full spatial geometric picture of fracture sets from rock outcrops, because much of the rock is not directly accessible. However, without taking into account the spatial distribution of geological structures the true geometry of joint patterns cannot be fully described and scaling laws, fractal or not, cannot be derived.

We present images of joint patterns based on datasets acquired by digital photographs which are processed to three dimensional images using the photogrammetry software Siro3D. This technique allows to obtain a highly accurate 3D picture of the visible outcrop. The spatial pattern of joints in nature is investigated using the software SiroJoint. For the analysis of joint systems a large data set was collected from the Heavitree Quarzite at Ormiston Gorge, near Alice Springs. The Heavitree Quartzite is fragmented by a spectacularly regular three-dimensional joint pattern, which is repeated at different scales and therefore represents a perfect laboratory for our investigations (Hobbs 1993). Siro3D generates a spatially fully referenced 3D image from overlapping digital images, such that each pixel of the image is assigned spatial coordinates. The software SiroJoint routinely constructs planes from the intersection of the rock-face with the linear trace of planar features (Poropat 2001). It provides stereographic plots of structural elements and additionally measures joint persistence, area, and joint spacing. Our measurements allow to analyse geometrical scaling relationships of joint sets with high accuracy and will help explore the character of their 3D complexity.

Several hundred joint planes were defined with SiroJoint in an Ormiston Gorge outcrop. Three different joint sets can be distinguished. Joint set one and two are characterized by steeply inclined planes with joint spacings ranging between 2 cm to 40 cm and 2 cm to 10 m respectively. Both joints sets depict a power law distribution in joint spacing/frequency plots. The third set is defined by a subhorizontal orientation. It shows a very regular spacing in the meter scale and lacks an exponen-

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tial distribution. We intend to use the results as a basis to compare observed fracture pattern with those generated by computational methods like Iterated Function Systems. This might help to understand how physical rock properties influence the spatial complexity of fracture systems and develop constitutive scaling relationships for certain rock types.

References

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