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Image processing based characterisation of coal cleat networks

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Abstract

Characterisation of the cleat network serves as the basis for estimating the hydraulic and mechanical seam properties which in turn are fundamental for flow and geomechanical modelling in the context of underground coal mining. Cleat and cleat network geometry can be described as a function of frequency, aperture, size, orientation relative to in situ stresses, connectivity and porosity, with mineralised and un-mineralised cleats occurring. To describe these properties, CT-scans of core samples of a Bowen Basin coal in central Queensland, Australia, are analysed.

A unique image processing workflow method is introduced to extract the key statistical parameters of perpendicular butt and face cleats present in a two-dimensional image. As face and butt cleats have different characteristics, the presented method distinguishes face cleats and butt cleats by direction and present detailed data for both cleat types. The results comprise cleat length, apertures, sizes, intensities, densities, shape parameter, spacing, orientation and connectivity and are therefore more comprehensive than previous cleat descriptions. Three generally different cleat geometries are considered within this study, one sample shows perpendicular face and butt cleats, the second two sets of face cleats intersected by butt cleats and the third parallel face cleats only.

Keywords

cleat geometry, image processing, coal properties, CT scans

1. Introduction

1.1. *Coal cleat networks*

Coal is characterised by its unique microstructure of a low permeable porous matrix intersected by a network of face and butt cleats. Cleats are natural opening-mode fractures within coal beds. Together with fault related and mining induced large-scale fractures, these small scale cleats provide the principal source of permeability for groundwater and gas flow within the seam (Laubach et al., 1998). In contrast to the fractures, the smaller systematic cleats do not cut clastic facies adjacent to the coal layers (Dron 1925). Cleats are distinguished by their orientation into two types (Figure 1a). Face cleats are dominant and are directed perpendicular to the bedding plane. The fewer orthogonal butt cleats generally terminate when they encounter face cleats (Laubach et al., 1998). Butt cleats are thought to accommodate relaxation of the stress which originally formed the face cleats. This leads to perpendicularity between both cleat types (Golab et al. 2013). Most research has been done on this orthogonal cleat system. For example, Robertson & Christiansen (2008) described the cleat system as a system consisting of cubic matrix blocks. However, Nick et al., 1995 observed more complex structure systems which need to be characterised differently. A variety of cleat patterns in