Distinct element analysis of the effect of rock stress on fracture geometry in shear zone

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Shear zone geometries are governed by the rheological properties of rock. The shear deformation is accomplished by fracturing and ductile flow in the brittle and ductile regime, respectively. En-echelon arrays of extension veins are also indicators of shear zones. It has been suggested that en-echelon vein arrays are likely to be formed in the semi-brittle regime, however, the physical factors causing a change of the shear zone geometry from brittle faults to en-echelon fracture arrays remain unclear. In this study, two-dimensional distinct element method (2D DEM) are used to simulate the fracturing processes in a brittle rock model by applying shear deformation to investigate the influence of stress condition on the fracture geometry. The simulations were conducted through the following procedure. First, a rectangle rock model was subjected to bi-axial isotropic compressive stress. Then, the rock model was deformed at a constant shear velocity. As a results of simulation, the fracture geometry changed with the confining stress level. When the confining stress was low, fractures formed in open mode, to be an en-echelon fracture array. On the other hand, when the confining stress was high, fractures formed in shear mode, and then they evolved into a larger discontinuity parallel to shear zone boundary. At intermediate stress level, the creation of both open mode and shear mode fractures was observed. These results suggest that the stress condition control the fracture mode and geometry in shear zone. It can be interpreted that en-echelon extension fracture arrays should occur under high pore pressure, or lithostatic pressure. At low pore pressure, or hydrostatic pore pressure, fractures could originate in shear mode, evolving into brittle faults.

Keywords: shear zone, en-echelon extension vein, pore pressure, distinct element method