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Relationship between formation of parallel faults and stress fields in rock mass

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Some parallel cracks and faults, which are caused by earthquakes and crustal deformations, can be observed as various sizes from crustal scale to laboratory scale. The mechanism of formation of these parallel faults is not well investigated, and there still remains an important geophysical subject. If we find the relationship between the formation of parallel faults and stress field applied to rock mass, we could infer stress field loaded to the crust from the pattern of faults. For interpretation of these cracks behaviors, many attempts have been made using fracture mechanics theory. These attempts have successfully represented the propagation of predefined cracks. However, it is difficult to describe the initiation and the coalescence of cracks using this theory. Thus, in the recent years, numerical modeling has been applied to study crack behaviors in rocks. In this study, we conducted numerical simulations of rock mass failure under different conditions to investigate the nucleation conditions.

In this study, we use the Hamiltonian Particle Method (HPM), one of the particle methods. In the particle methods, a continuum is represented as a set of particles and a motion of the continuum is approximated as a movement of the particles. Therefore, the particle methods do not need the calculation grids or elements and can describe the failure at faults or cracks. We assumed that a rock mass with rectangular shape consists of basalt. The calculation model is based on a three dimensional elastic body. The failure of rock mass is assumed to obey the Mohr-Coulomb failure criterion and the tensile and compressive strength of rock elements distribute following the Weibull distribution. As stress fields in rock mass, we applied compressive, shear and bending forces to rock mass and changed the direction and magnitude of these forces. Results of the simulations suggest that the confining pressure would have dominant influence for the initiation of parallel faults in compressive conditions and that the shear force would provoke the propagation of parallel fractures along the shear direction.

Keywords: fault, particle method