Modelling Fault Damage Zone Evolution: Effect of heterogeneity.

Heather Moir, Rebecca Lunn, and Zoe Shipton

University of Strathclyde, Civil Engineering, Glasgow, United Kingdom (heather.moir@strath.ac.uk)

Many faults grow by the linkage of smaller structures, and damage zones around faults may arise as a result of this linkage process. Numerical modelling previously carried out by the authors has shown that, in general, for a homogeneous crystalline rock type, fault zone structures are determined by: the ratio of $\sigma 1$ to $\sigma 3$; the orientation of the pre-existing features to $\sigma 1$; and the initial relative positions of neighbouring joints, specifically, contractional vs. extensional geometries and overlapping vs. under-lapping joints. In this paper we explore what effect increasing the host rock heterogeneity has on the evolving damage zone structures, this is carried out on different scales from a few meters to several kilometers. The heterogeneity was increased by either smoothly varying the material properties within a single rock type or by creating discrete changes by introducing multiple rock types. Different behaviour is predicted for smoothly varying properties and discrete changes. Increasing the heterogeneity within a single rock type by assuming a statistical variation in mineralogy, affects the detail of the fault zone which develops but not the general style of the overall fracture pattern. Smoothly varying material properties may inhibit, enhance or deflect a propagating fault but it does not facilitate the growth of new faults independent of the pre-existing features. When different lithologies are introduced, the discrete change in material properties strongly influences secondary faulting which evolves. As with smoothly varying properties, discrete changes may inhibit, enhance or deflect a propagating fault, but often this effect is more pronounced. In addition to this, the geometry of the discrete change can create stress concentrations at locations removed from pre-existing or propagating fractures which allows new features to evolve.