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Laboratory investigation of fracture propagation for cement samples by hydraulic fracturing under the tri-axial stress condition.

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Hydraulic fracturing for samples were carried out to investigate characteristics of fracture propagation depending on viscosities of injection fluid and in-situ stress states. Ten cubic samples with 20cm each side were produced using cement and cured in the water for more than one month. Samples were place in the true tri-axial compressive machine with three different principal stresses. Injection hole was drilled and sample was hydraulically fractured with the constant injection rate. Injection pressures with time and acoustic emission (AE) signals were measured during experiments. Patterns of fractures produced by hydraulic fracturing were investigated.
Breakdown pressures increased exponentially as viscosities of injection fluid increased. Pattern of fracture development varied depending on differential stresses which are the difference between the major and minor principal stresses. At low differential stress, multiple fractures which were sub-parallel to the major principal stress direction were propagated from the injection hole. In some samples, the fracture directions changed during propagation. However, a single fracture were propagated parallel to the major principal stress direction at high differential stress. Results of AE showed similar patterns. Contour map of AE source locations at low differential stress showed bigger width than those at high low differential stress, indicating that hydraulic fracturing for shale gas should be performed along the direction of the minimum differential stress.