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True-triaxial tests of anisotropic gneiss and pegmatite simulating the excavation and heating phases of canister hole emplacement

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True-triaxial tests of anisotropic gneiss and pegmatite simulating the excavation and heating phases of canister hole emplacement

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Abstract: Evaluation of the strengths and weaknesses of a heterogeneous anisotropic rock mass necessitates the geotechnical assessment of individual and combinations of isotropic and anisotropic components. This study investigates this complexity by studying the 3D stress path associated with the excavation, heating and cooling phases of the Posiva Olkiluoto Spalling Experiment, POSE. The damage from the boundary of the POSE test holes was found to be discontinuous, focused around areas where foliated gneiss was more abundant, specifically where foliation was more pronounced or closer to lithological contact between isotropic (pegmatite) and anisotropic members (veined micaceous gneiss). Due to the observations described above, extensive back-analyses was also conducted to attempt to determine the failure mechanism in situ. We used a true-triaxial geophysical imaging cell to evaluate a variety of field situations by following the stress path evolution for each principal stress component as a result of excavation, and heating of the experimental holes. Special attention was paid to investigate the angular relationship between intermediate principal stress axis and the strike direction of the foliation plane in the weakest member of the Olkiluoto rock. The effects of the intermediate principal stress axis in relation to the strike direction of foliation planes (30°- 45°specimens) were used to understand the localized damage zones which were observed to form at the boundary of test holes. Temporal and spatial acoustic emission, evolution of seismic wave velocities and fracture networks using Micro-CT scan images show that fracture initiation strength can be improved significantly when the intermediate principal stress axis is oriented normal to the strike of the foliation planes. Results show that when the weakest specimens are characterized with large amounts of non-compliant (at a high angle with the strike of foliation plane) pegmatite, fracture initiation and failure strength are positively affected. These specimens also show that fracture initiating strengths can increase by up to 3.5 times, accompanied with failure strength improvements of up to a 100