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Microcracks in aggregates and their influence on mechanical properties

Jakob Kloeve Keiding, Eirik Pettersen, and Eyolf Erichsen
Geological Survey of Norway. Trondheim, Norway (jakob.keiding@ngu.no)

Microcracks are of great importance in understanding the mechanical behavior of rocks and many studies have proposed that microcracks have a negative influence on the mechanical properties of rock aggregates. However, it remains unclear to what extend microcracks can be directly correlated to mechanical strength and used for quantitative petrographical analysis for the evaluation of functional properties.

To further test the possible relationship between microcracks and mechanical strength, we studied approx. 40 samples from northern Norway. The sample material was mafic and felsic intrusive rocks that have suffered relatively little metamorphic overprint. These samples were examined for resistance to fragmentation and wear by abrasion by the Los Angeles and the Nordic abrasion test methods, respectively. Cracks were also documented in three drill cores that were subjected to point load tests to examine variations in strength and microcracks with depth. In order to characterize the microcracks, samples were vacuum impregnated with epoxy resin containing fluorescent dye. Using fluorescent and polarized microscopy combined with digital image analyses, the areal extend of cracks, microcrack type and crack density was quantified.

Analysis of the microcracks shows great variation in crack density and frequency of different types of microcracks. Overall intragranular microcracks is dominating followed by intergranular cracks whereas transgranular cracks are the least abundant type. The crack abundance varies with the rock type and is highest in the felsic samples which all have > 1.5 cracks/mm and generally is lower in the mafic samples.

Correlation between crack density and several strength parameters has been observed. Microcracks appear to have the greatest impact on the point load strength and then the Los Angeles value where there is reasonably good covariance between crack density and the mechanical strength. On the other hand, no impact on abrasion properties investigated by the Nordic abrasion test method was observed. In conclusion, this study suggests that microcracks have a negative impact on the mechanical properties but also emphasizes the key role that other textural characteristics and mineralogy has on the mechanical strength of rock aggregates.