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Fracturing and brittleness index analyses of shales

Auke Barnhoorn (1), Mutia Primarini (1), and Maartje Houben (2)

(1) Delft University of Technology, Department of Geoscience and Engineering, Delft, Netherlands (auke.barnhoorn@tudelft.nl), (2) Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands

The formation of a fracture network in rocks has a crucial control on the flow behaviour of fluids. In addition, an existing network of fractures , influences the propagation of new fractures during e.g. hydraulic fracturing or during a seismic event. Understanding of the type and characteristics of the fracture network that will be formed during e.g. hydraulic fracturing is thus crucial to better predict the outcome of a hydraulic fracturing job. For this, knowledge of the rock properties is crucial. The brittleness index is often used as a rock property that can be used to predict the fracturing behaviour of a rock for e.g. hydraulic fracturing of shales. Various terminologies of the brittleness index (BI1, BI2 and BI3) exist based on mineralogy, elastic constants and stress-strain behaviour (Jin et al., 2014, Jarvie et al., 2007 and Holt et al., 2011). A maximum brittleness index of 1 predicts very good and efficient fracturing behaviour while a minimum brittleness index of 0 predicts a much more ductile shale behaviour.

Here, we have performed systematic petrophysical, acoustic and geomechanical analyses on a set of shale samples from Whitby (UK) and we have determined the three different brittleness indices on each sample by performing all the analyses on each of the samples. We show that each of the three brittleness indices are very different for the same sample and as such it can be concluded that the brittleness index is not a good predictor of the fracturing behaviour of shales. The brittleness index based on the acoustic data (BI1) all lie around values of 0.5, while the brittleness index based on the stress strain data (BI2) give an average brittleness index around 0.75, whereas the mineralogy brittleness index (BI3) predict values below 0.2. This shows that by using different estimates of the brittleness index different decisions can be made for hydraulic fracturing. If we would rely on the mineralogy (BI3), the Whitby mudstone is not a suitable candidate for hydraulic fracturing while if we would rely on stress-strain data (BI2) the Whitby mudstone would be a very good candidate. We are aiming to perform these kind of measurements on a wide variety of shales with varying compositions and origins etc. and compare all results and come up with a better brittleness index, as well as link the brittleness indices to the fracturing behaviour seen in the samples.

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