Geophysical Research Abstracts
Vol. 17, EGU2015-9878, 2015
EGU General Assembly 2015

Fracture-fault network characterization of pavement imagery of the Whitby Mudstone, Yorkshire

Quinten Boersma (1), Nico Hardebol (2), Maartje Houben (1), Auke Barnhoorn (2), and Martyn Drury (1)
(1) Dep. of Earth Sciences, Utrecht University, NL., (2) Dep. of Geoscience & Engineering, Delft University of Technology, Netherlands

Natural fractures play an important role in the hydrocarbon production from tight reservoirs. The need for fracture network pathways by fraccing matters particularly for shale gas prospects, due to their micro- to nano-darcies matrix permeabilities. The study of natural fractures from outcrops helps to better understand network connectivity and possibility of reactivating pre-existing planes of weakness, induced by hydraulic stimulation. Microseismicity also show that natural fractures are reactivated during fraccing in tight gas reservoirs and influence the success of the stimulation. An accurate understanding of natural fracture networks can help in predicting the development of fracture networks. In this research we analyze an outcrop analogue, the Whitby Mustone Formation (WMF), in terms of its horizontal fracture network. The WMF is the time equivalent of the Posidonia Shale Formation (PSF), which on itself is the main shale gas prospect in the Dutch subsurface.
The fracture network of the WMF is characterized by a system of steep dipping joints with two dominant directions with N-S and E-W strike. The network was digitized from bird-view imagery of the pavement with a spatial extent of $\sim$100 m at sub-cm resolution. The imagery is interpreted in terms of orientation and length distributions, intensity and fractal dimensions. Samples from the field were analyzed for rock strength and sample mineralogy.
The results indicate that the fracture networks greatly differ per bed. Observed differences are for example; the geometry of the fracture network, its cumulative length distribution law, the fracture intensity, the fracture length vs its orientation and the fractal dimension. All these parameters greatly influence fracture network connectivity, the probability that longer fractures exist within the pavement and whether the network is more prone to clustering or scattering. Apart from the differences, the networks display a fairly similar orthogonal arrangement with dominant large (> 5-10 m) N-S striking fractures and smaller E-W striking cross-joints (< 2-3 m). A nested network arrangement is indicated by some smaller-scale N-S fractures abutting against the E-W striking ones. Furthermore, abutment relations provide some constraints on relative time. Timing indications with respect to burial-exhumation are difficult to establish. Some joints are cemented and measurable from the high-resolution imagery. The vein measurements helped establishing a first order relation between the fracture aperture with respect to their length and confirm that longer fractures have a wider aperture.
The above stated parameters and results all prove to be very valuable information which can help predict the geometries of the different fracture networks present within the PSF. It is important to understand the possible mechanisms which can cause these differences in fracture network characteristics. Bulk lithological variations between beds are minor, mainly consisting of clay minerals. Furthermore, some quartz and pyrite is present in all samples and TOC is present in variable amounts. However, the occurrence of concretions up to 0.5m in size correlates with notable differences in distinct network arrangement. Therefore it appears that the presence of these concretions greatly alters the overall strength of the rock, hence the fracture network geometry.