Geophysical Research Abstracts
Vol. 19, EGU2017-9012, 2017
EGU General Assembly 2017

Investigation of water-soluble organic matter extracted from shales during leaching experiments

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The huge volumes and unknown composition of flowback and produced waters cause major public concerns about the environmental and social compatibility of hydraulic fracturing and the exploitation of gas from unconventional reservoirs. Flowback and produced waters contain not only residues of fracking additives but also chemical species that are dissolved from the shales themselves during fluid-rock interaction. Knowledge of the composition, size and structure of dissolved organic carbon (DOC) as well as the main controls on the release of DOC are a prerequisite for a better understanding of these interactions and its effects on composition of flowback and produced water. Black shales from four different geological settings and covering a maturity range Ro = 0.3-2.6% were extracted with deionized water. The DOC yields were found to decrease rapidly with increasing diagenesis and remain low throughout catagenesis. Four DOC fractions have been qualitatively and quantitatively characterized using size-exclusion chromatography. The concentrations of individual low molecular weight organic acids (LMWOA) decrease with increasing maturity of the samples except for acetate extracted from the overmature Posidonia shale, which was influenced by hydrothermal brines. The oxygen content of the shale organic matter also shows a significant influence on the release of organic acids, which is indicated by the positive trend between oxygen index (OI) and the concentrations of formate and acetate. Based on our experiments, both the properties of the organic matter source and the thermal maturation progress of the shale organic matter significantly influence the amount and quality of extracted organic compounds during the leaching experiments.