

Impact of geochemical interactions between hydraulic fracturing fluid and Whitby Mudstone on mineralogy and fracture permeability

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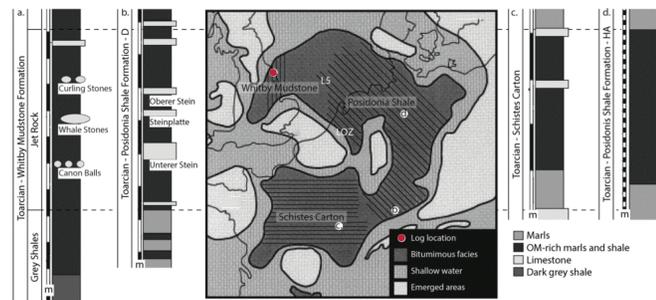
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Introduction

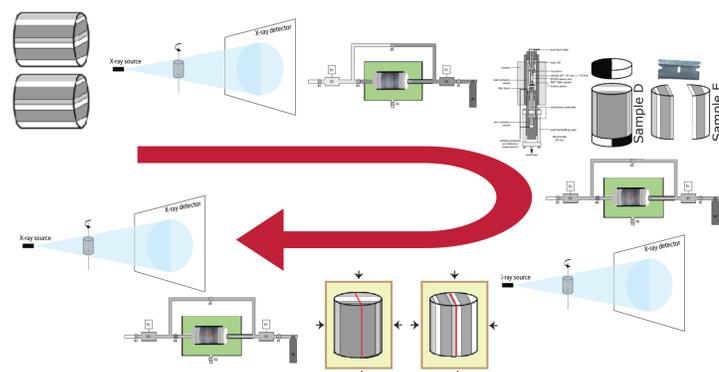
Development of unconventional shale oil and gas reservoirs combines mechanical and chemical stimulation in horizontal wells that extend for hundreds to thousands of meters within organic-rich formations. Chemical imbalance between the shale and injected fluids potentially drives geochemical reactions that may alter the properties of the rock. Simultaneously, induced fracturing may drive physical changes that alter geochemical water-rock interactions. We examine how a mechanically-induced fracture network may alter geochemical reaction pathways between shale and stimulation fluid used in hydraulic fracturing and the impact this may have on (fracture) permeability. We studied two fractured samples taken from the Whitby Mudstone (UK), consisting of bituminous, dark grey mudstone (TOC = 4-15%). One sample was cleaved along the bedding plane, while the second sample was deformed in direct shear to induce multiple fractures, with a surrounding damage zone.

Samples

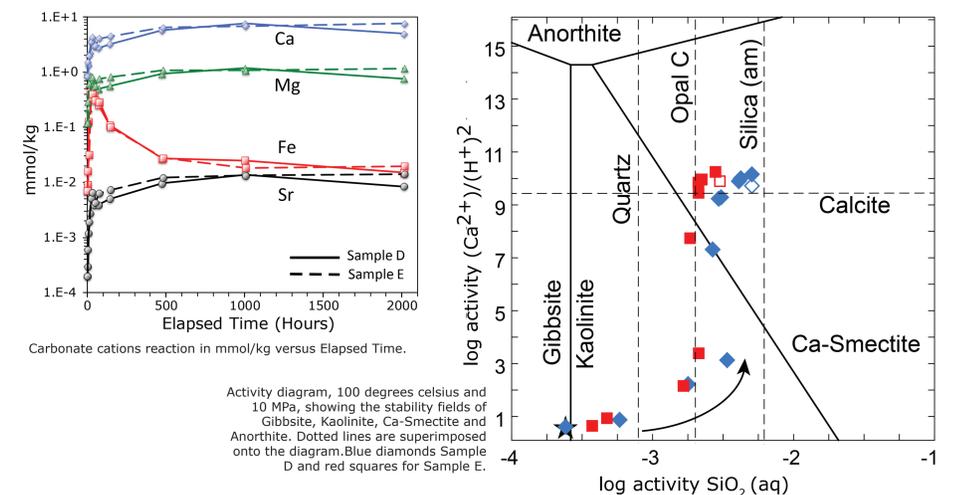
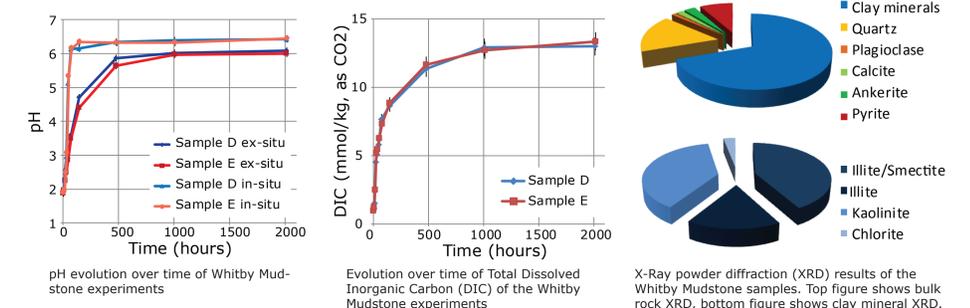
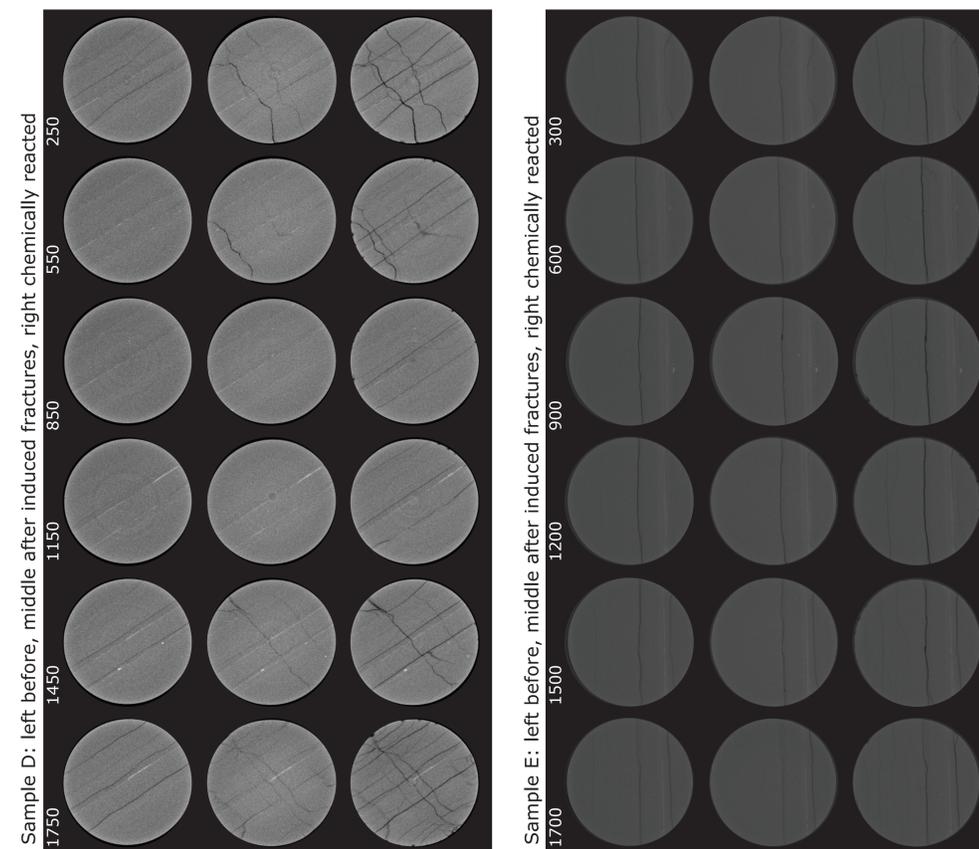
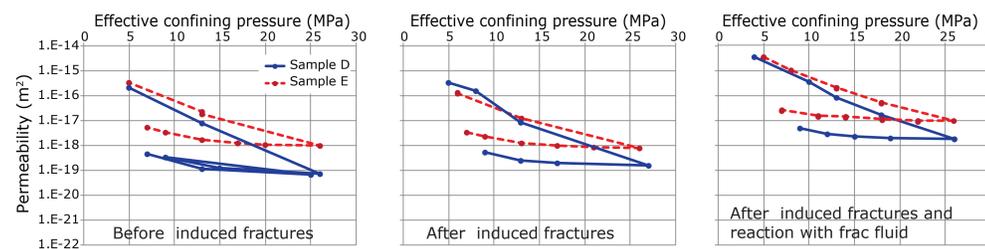
We investigated Whitby Mudstone, an analogue for many caprocks, source rocks and shale gas plays in Europe.



Methods



Results



Conclusion

- 1) Permeability increases slightly after mechanical induced fractures, but is similar when the core is simply split in half. After reaction with the frac fluid for > 1800 hours (and the rock was exposed to an extra wetting and drying cycle) permeability went up by an order of magnitude in both samples.
- 2) The dissolution of calcite is apparently rapid enough to limit $a_{Ca^{2+}}/(a_{H^+})^2$.
- 3) Carbonate solubility controls aqueous Ca, Mg and Sr. Aqueous Fe is initially elevated at low pH but decreases once carbonate buffers the system to more neutral pH.
- 4) Silica activity is apparently controlled by Opal in the Whitby E experiment; silica activity is slightly greater in the Whitby D experiment.
- 5) Ca smectite is the stable aluminosilicate alteration product.

Acknowledgements

Kaszuba's work was supported by the University of Wyoming School of Energy Resources and a Nielson Energy Fellowship. Houben is supported by the Netherlands Organisation for Scientific Research through a VENI grant (NWO; 016.Veni.171.041).