Alteration of kerogen during reaction with hydraulic fracturing fluid

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The use of hydraulic fracturing of tight shales to produce oil and natural gas has grown significantly in recent years, yet it remains relatively inefficient, recovering only an estimated 5% and 25% of the oil and gas present, respectively. The need to improve efficiency and diminish environmental impact has prompted research into fundamental geochemical reactions occurring in shales. In particular, reactions between kerogen and fracture fluid components are poorly understood. Kerogen is the precursor of these hydrocarbons and contains metals in addition to organic material; it is also electron rich and therefore susceptible to oxidation and release of a variety of elements. However, kerogen is generally considered to be relatively unreactive. Here we have investigated reactions between isolated Green River (Type I, immature) and Marcellus (Type II, mature) kerogens and a hydraulic fracturing fluid typical of that used in the Marcellus shale. These experiments show that both kerogens react with fracture fluid, although to different extents. Reaction of kerogen with fracture fluid results in loss of carbon content, alteration of organic functional groups, and release of contaminants. Alteration of kerogen has multiple implications, including possible changes in transport of both fracture fluid and hydrocarbons due to alteration of wettability, gas sorption and storage, as well as the composition of produced waters. Our results also emphasize the need for further characterization of kerogen and its reactions with complex hydraulic fracturing fluids.