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Microfracture propagation in layered shale rocks during primary migration

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Primary migration in shales controls the expulsion of gas and oil from the source rock into a reservoir and the long term permeability of caprocks. Experimental studies that use dynamic in-situ X-ray tomography have shown that, under heating, an immature shale produces hydrocarbon that is expelled through the formation of microfractures that increased rock porosity (e.g. Kobchenko et al., 2011). These experiments have motivated a numerical model with microfractures developed into a homogeneous isotropic elastic solid due to local overpressure generated by the formation of hydrocarbons (Goulart-Teixeira et al. 2017). Here, we model the hydro-mechanical behavior of fracture propagation during maturation in anisotropic rocks using Discrete Elements Method coupled with a fluid flow model. We consider a layered rock where different material properties (Young's modulus, Poisson's ratio, strength) in successive layers. We simulate fracture propagation driven by local fluid production. The fluid is produced by the maturation of kerogen patches distributed in the shale. Results show that the distribution of local stresses within each layer plays a major role in controlling the direction of fracture propagation. We estimate the preferential direction of fracture propagation allowing primary migration depending on material properties and applied stress.

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