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Challenges in the development of shale hydrocarbon resources and CO_2 based method for shale hydrocarbon extraction: review and implications

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In recent years, shale hydrocarbon resources are gaining extensive interest due to the increasing demand for secure and stable energy resources throughout the world. The technological advancement in horizontal drilling and multistage hydro-fracking techniques has made the extraction of hydrocarbon from low or ultra-low permeability shale reservoir commercially viable. Horizontal drilling technology is used to increase the contact surface area between the shale reservoir and the wellbore. Hydro-fracking is a stimulation technique in which water-based fracking fluid is commonly used to create fracture networks in the formation and to enhance production from shale reservoirs. The major environmental issues associated with hydro-fracking are (a) plenty of water consumption causing scarcity of water in drought areas, (b) chemical mixed with water used for fracking may get leaked to the groundwater and surface water causing water pollution, and (c) only a part of the fracking water can be reused for fracking, majority of wastewater is injected into underground wells (Zoback et al., 2010; He et al., 2020).

Moreover, for the development of high clay content shale reservoirs like Cambay Shale of India, use of water-based fracking method will cause clay-swelling which will reduce the matrix permeability and decrease the release of oil and gas from the shale matrix (De et al., 2020). Clay minerals have high surface area and high cation exchange capacity which increases the reactivity of clay minerals with water, thus causes swelling of clay minerals (Rogala et al., 2013; Zhang et al., 2017). Considering the environmental issues associated with hydro-fracking and to enhance production from high clay content shale plays, non-water-based fracturing fluids like CO_2 based method can be preferred (Zhang et al., 2017). In CO_2-based-method, supercritical CO_2 mixed with proppants is injected under high pressure into the formation to induce fractures (Pei et al., 2015). Also, the usage of CO_2 may prove beneficial as displacing fluid in the recovery stage and can enhance the oil and gas recovery (Pei et al., 2015; Jia et al., 2019). Additionally, storage of large volume of CO_2 used for shale hydrocarbon exploitation in the deep formation will reduce the concentration of greenhouse gases in the atmosphere (He et al., 2020), providing an appropriate sink and help in for a 'low carbon economy'.

Biography

Sanjukta De has her Master degree in Applied Geology from Jadavpur University and currently a PhD student at the Indian Institute of Technology Kharagpur, India. Her areas of interests are shale hydrocarbon exploration, application of machine learning techniques in hydrocarbon exploration, processing and interpreting subsurface geophysical data mainly wireline logging data for hydrocarbon exploration, and assessing the impact on the environment for shale hydrocarbon exploitation. She has published four research papers in international journals with SCI and Scopus indexing. She has presented her works in various international and national conferences like the Fall meeting of the American Geophysical Union, Annual Meeting of Geological Society of America, European Geosciences Union General Assembly, etc. She has served as a reviewer of many international journals like the American Association of Petroleum Geologists Bulletin, Journal of Natural Gas Science and Engineering, and Geoscience Journal.