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Numerical modeling of fracking fluid and methane migration through fault zones in shale gas reservoirs

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Hydraulic fracturing operation in shale gas reservoir has gained growing interest over the last few years. Groundwater contamination is one of the most important environmental concerns that have emerged surrounding shale gas development (Reagan et al., 2015). The potential impacts of hydraulic fracturing could be studied through the possible pathways for subsurface migration of contaminants towards overlying aquifers (Kissinger et al., 2013; Myers, 2012). The intent of this study is to investigate, by means of numerical simulation, two failure scenarios which are based on the presence of a fault zone that penetrates the full thickness of overburden and connect shale gas reservoir to aquifer. Scenario 1 addresses the potential transport of fracturing fluid from the shale into the subsurface. This scenario was modeled with COMSOL Multiphysics software. Scenario 2 deals with the leakage of methane from the reservoir into the overburden. The numerical modeling of this scenario was implemented in DuMux (free and open-source software), discrete fracture model (DFM) simulator (Tatomir, 2012). The modeling results are used to evaluate the influence of several important parameters (reservoir pressure, aquifer–reservoir separation thickness, fault zone inclination, porosity, permeability, etc.) that could affect the fluid transport through the fault zone. Furthermore, we determined the main transport mechanisms and circumstances in which would allow frack fluid or methane migrate through the fault zone into geological layers. The results show that presence of a conductive fault could reduce the contaminant travel time and a significant contaminant leakage, under certain hydraulic conditions, is most likely to occur.

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