Mass transport in fault zones: transition from nonlocal to normal transport

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Fault zones clearly affect the flow paths of fluids at the scale of geothermal reservoirs. Fault-related fracture damage decreases to background levels with increasing distance from the fault core according to a power law. This study investigates mass transport in such a fault-related structure using nonlocal models. A column flow experiment has been conducted to create a permeability distribution that varies with distance from a main conduit. The tracer response curve describes a preasymptotic curve implying subdiffusive transport, which is slower than the normal Fickian diffusion. As long as permeability of the surrounding layers varies with distance from a main conduit, the tracer response can be modeled by the time fractional advection dispersion equation (time fADE). In contrast, if the surrounding area is a finite domain, an upper truncated behavior in tracer response (i.e., exponential decline at late time) is observed. The tempered anomalous diffusion (TAD) model captures the transition from sub-diffusive to Fickian transport, which is characterized by a smooth transition from power-law to an exponential decline in the late-time breakthrough curves.

Keywords: time fractional derivative, fractured reservoir, flow experiment, fractal scaling, truncated power-law distribution

