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Modeling Species Transport by Concentrated Brine in Aggregated Porous Media

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Abstract. Basic equations governing the transport of species by concentrated brine flowing through an aggregated porous medium are developed. Some simple examples are solved numerically. The medium is considered to be composed of porous rock aggregates separated by 'macropores' through which the brine flows and transport of salt and low-concentration species takes place. The aggregates contain dead-end pores, cracks, and stationary pockets collectively called 'micropores'. The micropore space does not contribute to the flow, but it serves as a storage for salt and species. Adsorption of fluid species takes place at internal surface of aggregates where it is assumed that a linear equilibrium isotherm describes the process. The effects of high salt concentrations are accounted for in the brine density relation, the viscosity relation, Darcy's and Fick's laws, and the rate of mass transfer between macropores and micropores. Mass balance equations, supplemented by extended forms of Darcy's and Fick's laws, are employed to arrive at two sets of equations. One set consists of seven coupled equations for the salt mass fraction and fluid density in macropores, salt mass fraction in micropores, fluid velocity vector, and the fluid pressure. The other set consists of two coupled equations to be solved for the mass fractions of low-concentration species in micropores and macropores. Based on these equations, a mathematical model called TORISM is developed. Using this model, the potential significance of modifications to Darcy's Law are demonstrated.

Key words. Brine transport, species transport, radionuclides, aggregated porous media, micropores, macropores, structured porous media, Darcy's law, Fick's law.