The interpretation of geochemical patterns through the theory of hyperbolic conservation laws for reactive transport in porous media

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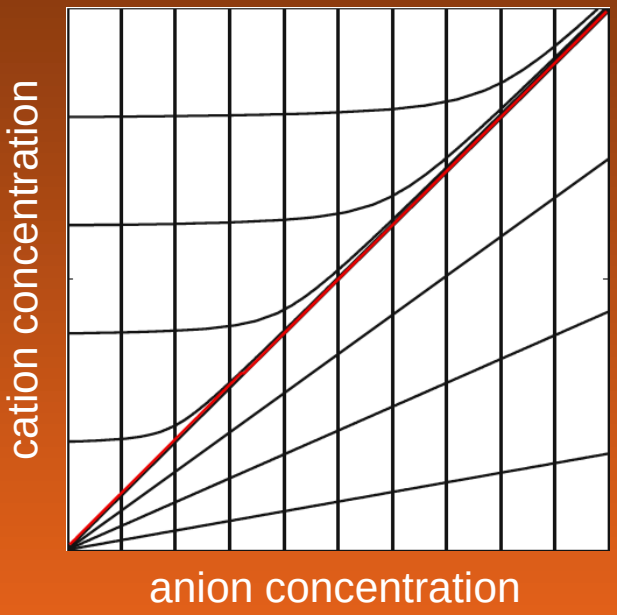

The hyperbolic theory predicts compositional variations due to different processes and their spatial relations, but this framework is currently not used in the interpretation of geochemical and isotopic data.

The analysis is based on the insight that the pattern of the concentration profiles is self-similar, i.e. identical after a scaling the distance with time, x/t. This allows the reduction of the system of coupled partial differential equations governing reactive transport $\nabla_c \mathbf{c}_t + \mathbf{c}_x = 0$

to a system of ordinary differential equations in form of an eigenvalue problem, given by $(\nabla_c + (t/x)\mathbf{I})\,\dfrac{\mathrm{d}\mathbf{c}}{\mathrm{d}(t/x)} = 0\,.$

The grid of eigenvectors in composition space (shown on the left) provides a road map for the construction of analytic solutions for coupled reactive transport problems, such as those shown below that illustrate leakage of a radionuclide or heavy metal into an aquifer.