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Interaction of topography- and salinity-driven groundwater flow in synthetic numerical models and a real geological situation

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Two-dimensional numerical investigation has been accomplished in order to investigate how the solute concentration influences the topography-driven groundwater flow along a section from Buda Thermal Karst to Gödöllő Hills in Hungary (Fodor 2011).

First, an extensive numerical testing has been carried out to validate the applicability of the finite element numerical software package, COMSOL Multiphysics for modelling solute transport in groundwater flow. The onset and the pattern of convection obtained from numerical modelling were compared with the analytical solutions in horizontal and inclined model boxes. Numerical results agree well with the analytical results concerning both the critical Rayleigh number and the transition from multi- to unicellular flow pattern depending of the inclination angle of the model box.

Second, the interaction of the topography- and composition-driven groundwater flow was systematically studied in a simple two-dimensional synthetic model domain. It was established that (1) an increase in the density difference between fresh and salt water decreases the average Darcy flux in the basin, (2) a high anisotropy of hydraulic conductivity (horizontal/vertical) facilitates the separation of the shallow fresh and deep salt water, while (3) a high transverse dispersivity slightly enhances the solute transport between the flow regimes. Regional fresh water flow induces a sluggish inner convection in the compositionally dense salt water zone, which has Darcy flux lower by 1–2 orders of magnitude.

Finally, total dissolved solid (TDS) content of groundwater was investigated along a section from Buda Thermal Karst to Gödöllő Hills in Hungary. The distribution of the measured TDS values is compared to the solute concentration, temperature anomaly and flow pattern obtained from a numerical thermohaline groundwater flow model.

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