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Modelling long term biodenitrification processes from column experiments: Insight in how feeding strategy affect hydraulic properties

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We developed a reactive transport model that reproduced a 342 days long laboratory column experiment of biodenitrification processes with different injection strategies in terms of frequency (daily, weekly) and C:N ratio. Furthermore, we evaluated changes in hydraulic properties as result of biodenitrification. It was found that biodenitrification promoted the transition from normal to anomalous (non-Fickian) transport due to the increase of heterogeneity in hydraulic parameters. Comparing the breakthrough curves from two conservative bromide tracer tests performed at the beginning and at the end of the experiment, two significant features were observed: first, an increase in dispersivity, and second, a transition from a curve that can be modeled with an advection-dispersion equation to a different one that can be modeled using a dual domain mass transfer model. This behavior is associated to the presence of a diffusive layer promoted by biofilm growth during the last 100 days of the experiment. Regarding the injection conditions, it was found that besides other parameters described in the literature (nutrient loading, flow rate, and grain size), injection frequency significantly modifies dispersivity, being largest for continuous injection. Moreover, reducing the C:N ratio for optimizing costs was possible after a substantial biomass developed. A careful design of injection conditions and substrate rates can then be devised in specific cases to promote biodenitrification.