Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.38362

Equivalent Porosity for Simulating Advective Transit Times in Regional-Scale Models

DOUGLAS KIP SOLOMON

University of Utah

Regional groundwater flow models are seldom discretized to the scale of individual layers but instead make use of equivalent hydraulic properties in which multiple layers are lumped together, and equivalent (bulk or lumped) hydraulic parameters are used. However, both production and monitoring wells are often screened only in layers having high hydraulic conductivity (K). When comparing environmental tracer data (from wells that are effectively biased by sampling high K layers), to simulated advective transit times, simulation need to utilize both equivalent (lumped) hydraulic conductivity values **and** equivalent porosity values. For a horizontally layered system with only horizontal flow the equivalent porosity is a function of the arithmetic mean of the thickness weighted K of individual layers. When the transmissivity of a high K layer is much greater than other layers, the equivalent porosity (n_{eq}) can be approximated as the fraction of the model thickness having high K times the actual porosity.

The concept of using an equivalent porosity will be demonstrated for regional groundwater flow adjacent to Great Salt Lake (GSL), Utah (USA). Groundwater age data from production wells indicate a near linear increase in age with distance from the Wasatch Mountains (the presumed location of recharge based on noble gas thermometry and hydroclimate data; Carter, 2025). To evaluate these observations in the context of physical groundwater flow, we have utilized a simple two-dimensional (cross sectional) flow model for steady-state flow. The model thickness ranges from about 1500 m below GSL to about 2000 m beneath the crest of the Wasatch Mountains. Stream function theory was used to estimate advective transit times along flow tubes. Simulated and observed ages agree reasonably well, but only when n_{eq} of 0.03 is utilized, suggesting that only about 10% of the aquifer (with a nominal porosity of 0.3) is effectively conducting groundwater. This 10% is also consistent with the fraction of the subsurface that is screened in production wells.

References

Carter, S. C. (2025). *Using Environmental Tracers to Develop a Conceptual Framework of Groundwater Inflow into Farmington Bay, Great Salt Lake, UT* https://login.ezproxy.lib.utah.edu/login?url=https://www.proquest.com/dissertations-theses/using-environmental-tracers-develop-conceptual/docview/3270169599/se-2