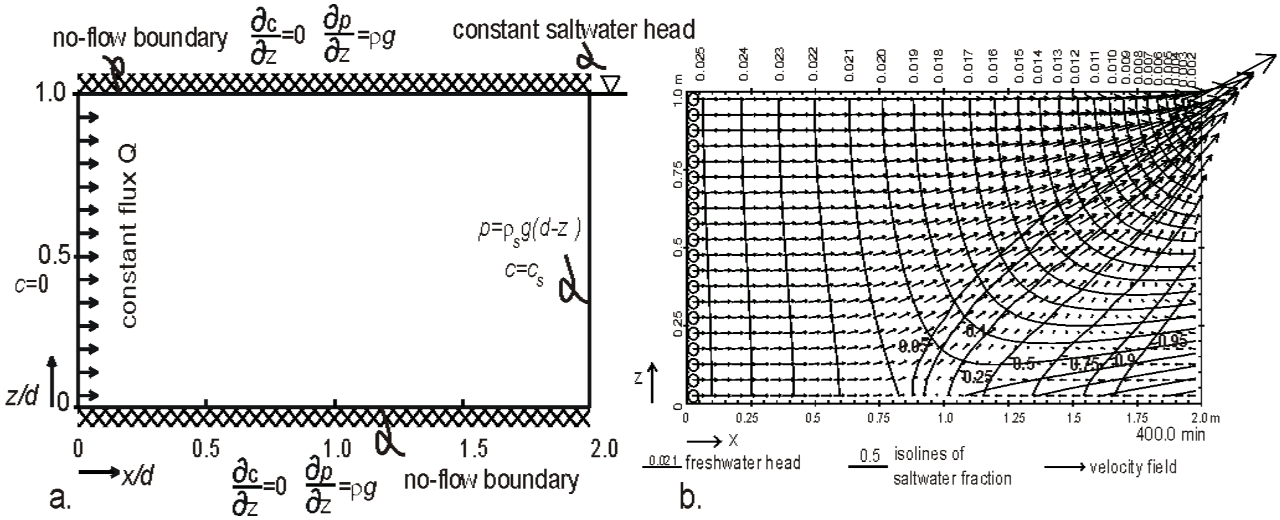
Henry’s case: Biscayne aquifer, Florida USA

Variable-density groundwater flow modelling with SEAWAT



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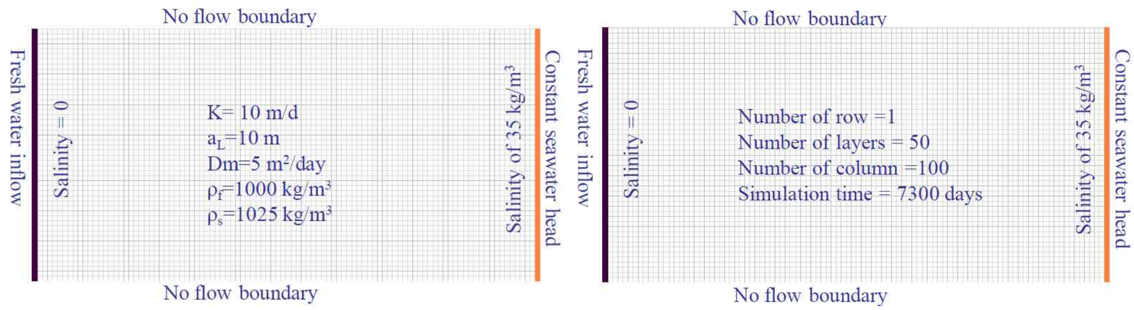
Introduction

Henry’s problem addresses the steady-state solution of a diffused saltwater wedge within a confined aquifer. Fresh water enters the confined aquifer at a constant rate from inland boundary and discharges into coastal boundary. Saltwater from the coastal boundary advances and mixes with the discharging fresh water.

Profile (cross-section) of Henry's case: aquifer thickness=500m, length=1000m

Parameters			
Layers	50	K_{hor}	10 m/d
Rows	1	Anisotropy K_{hor}/K_{ver}	1
Columns	100	Eff. porosity n_e	0.35
Δx	10 m	αL	10.0 m
Δy	1 m	αT	1.0 m
Δz	10 m	Moleculair diffusion	5 m2/d
Stress period	1	Specific storage	0.0001
Length of time	7300 days	Salinity seawater	35 kg/m^3
		Buoyancy	0.025

Parameters



Step 1 Numerical model grid

(1) Mesh size:
- a. Number of layers=50; Model thickness=500m; Model top elevation=500m
- b. Number of rows=1; Model extent=1m
- c. Number of columns=100; model extent=1000m
- d. Vertical exaggeration=1

(2) Layer property
- a. All layers=confined

(3) Boundary (IBOUND-MODFLOW)
- a. Cell values = 1 (active) for columns 1 to 99
- b. Cell values =-1 (constant head) for column=100

(4) Boundary (ICBUND-Transport models)
- a. All cell values=1 (active)

(5) Top elevation
- a. Layer 1=500m; ...., layer 50=10m

(6) Bottom elevation
- a. Layer 1=490m; ...; layer 50=0m

Step 2 Parameters

(1) Time:
- a. Time unit=days
- b. Simulation=transient
- c. Stress period=1
- d. Period length=7300 days
- e. Number of time steps=730

(2) Initial hydraulic heads
- a. All cells=1m

(3) Horizontal hydraulic conductivity
- a. All cells=10m/d

(4) Vertical hydraulic conductivity
- a. All cells=10m/d

(5) Specific storage
- a. All cells=0.0001m

(6) Effective porosity
- a. All cells=0.35

Step 3 MODFLOW packages

(1) Well

a. Injection rate at all cells in the first column = 1 m^3/d to simulate inflow from east boundary

(2) Solver package

a. PCG2

Step 4 MT3DMS/SEAWAT packages

(1) Simulation settings

a. Species: Salt

b. SEAWAT (default)

(2) Initial concentration

a. All cells =0

b. Cells in the last column=35kg/m^3 for seawater

(3) Advection

a. Use default

(4) Dispersion

a. α_T/α_L=0.1

b. α_L=10m for all cells

(5) Species dependent diffusion

a. D_m=5m^2/d for all cells

(6) Sink/Source concentration

a. Constant head cells: Salt=35 kg/m^3; (other cells: Salt=0)

b. Well: salt=0

(7) Solver

a. GCG

(8) Concentration observations

a. OBS1: x=795m, y=1m, layer=35

b. OBS1: x=845m, y=1m, layer=40

c. OBS1: x=995m, y=1m, layer=44

(9) Output control

a. Output times: minimum=365; maximum=7300 with interval=365

Step 5 Run models

(1) Run MODFLOW

(2) Run SEAWAT

Step 6 Presentation of model results

(1) Contour map of salt concentrations

(2) Break-through curves

(3) Animate evolution of mixing

Step 7 Implement a shallow groundwater extraction well in the coastal zone, 250m from the sea.

What are the effects?

Step 8 Insert a measure to reduce salt water intrusion

What is the measure, what do you expect and are the effects?