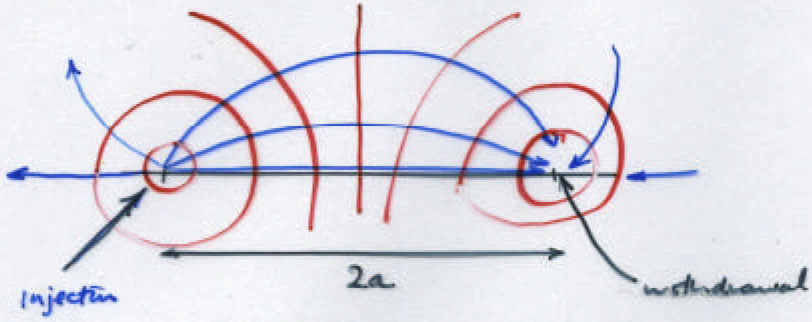
5.7.3 Twin Well Tracer Test



1. Inject tracer
2. Record outlet at withdrawal well.

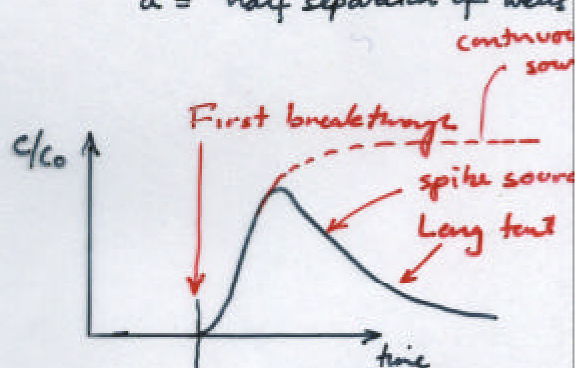
Transit time for plug flow: along a given streamline

$$t_\theta = \frac{4\pi a^2 b}{q \sin^2\theta}\left(1 - \frac{\theta}{\tan\theta}\right)$$

q = injection rate
θ = streamtube "angle"
b = aquifer thickness
a = half separation of wells

$$L = \frac{2a\theta}{\sin\theta}$$

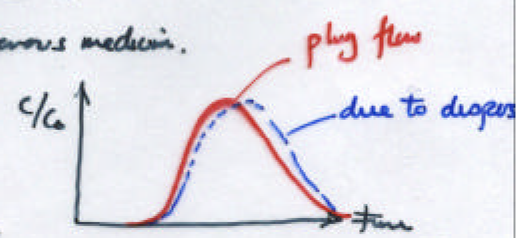
Fit measured curve to theoretical curve



$$t_\theta = \frac{4\pi a^2 b}{q \sin^2\theta}\left(1 - \frac{\theta}{\tan\theta}\right)\Bigg|_{\theta=0}$$

Problems:

- Test induces dispersion due to nature of test, alone.
  ∴ obscures actual dispersion due to the porous medium.



- Natural gradient tests preferred
- Avoids this "geometric" dispersion due to severe flow-field

NATURAL GRADIENT

Evaluation of advective vel, $V_x = \ell / t$

t(d)	ℓ(m)	V(m/d)
85	9.5	0.11
462	38	0.08
647	61	0.09

$\bar{V} \simeq 0.09$ m/d

Evaluation of Dispersivity, D_x

$3\sigma_x = 3\sqrt{2D_x t}$ $\quad D_x = (3\sigma_x)^2 / 18t$

Half length ($3\sigma_x$)	Time (t)	Dispersivity D_x
5m	85	.016 m²/d
14m	462	.023
15m	647	.019

$\bar{D}_x = .019$

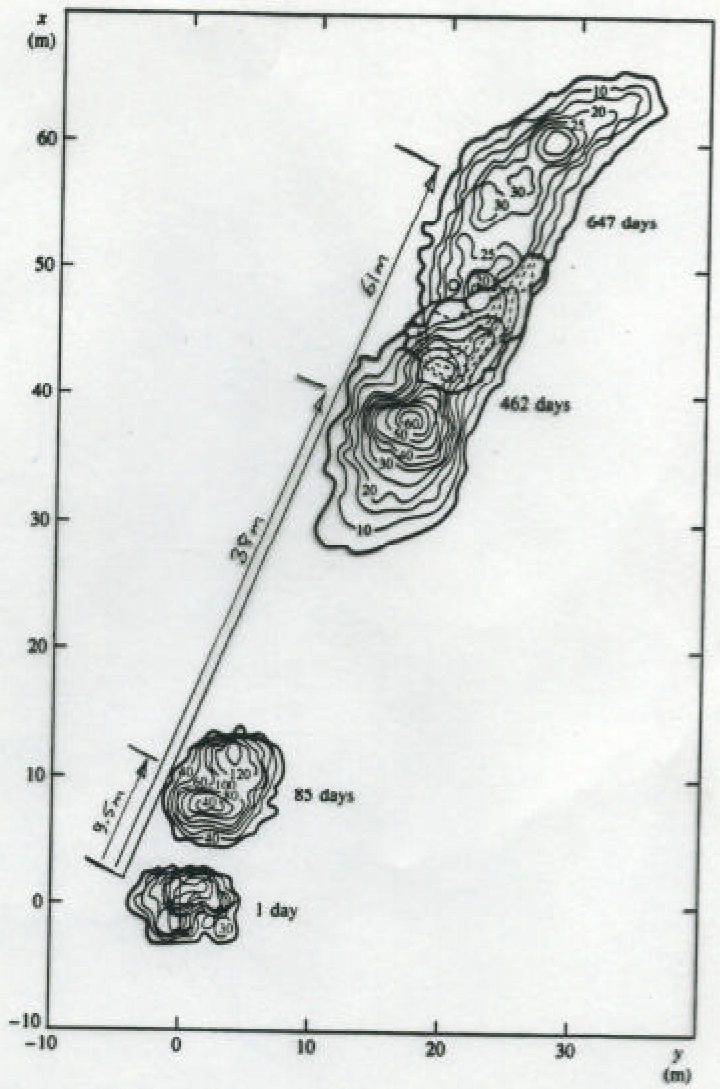


FIGURE 2.13 Vertically averaged chloride concentration at 1 day, 85 days, 462 days, and 647 days after the injection of a slug into a shallow aquifer. *Source:* D. M. Mackay et al. *Water Resources Research* 22, no. 13 (1986):2017–29. Copyright by the American Geophysical Union.

Transverse Dispersivity, D_y

Half length ($3\sigma_y$)	Time (t)	Dispersivity D_y
4.5m	85	.013 m²/d
6.0	462	.004
6.5	647	.004

$\bar{D}_y \simeq .007$ m²/d

Compare with estimate: $\alpha_L = \frac{1}{10} x$

x = scale of measurement $\simeq 61$m

$D_L = \cancel{D^*}^{\,0} + \alpha_L V_x = (6.1\text{m})(0.09\text{ m/d})$

$D_L = 0.55$ m²/d

not very close to 0.019 m²/d.