Influence of Particle Sizes on Solute and Heat Transport Interpretation

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This presentation participates in OSPP

EGU

Outstanding Student & PhD candidate Presentation contest

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● LABORATORY EXPERIMENTS USING TWO DIFFERENT POROUS MEDIA

	Sand 1	Sand2
Mean grain size (d_{50}, [mm])	0.76	0.52
Uniformity coefficient [-]	1.50	1.41

❖ Schematic diagram of experimental system
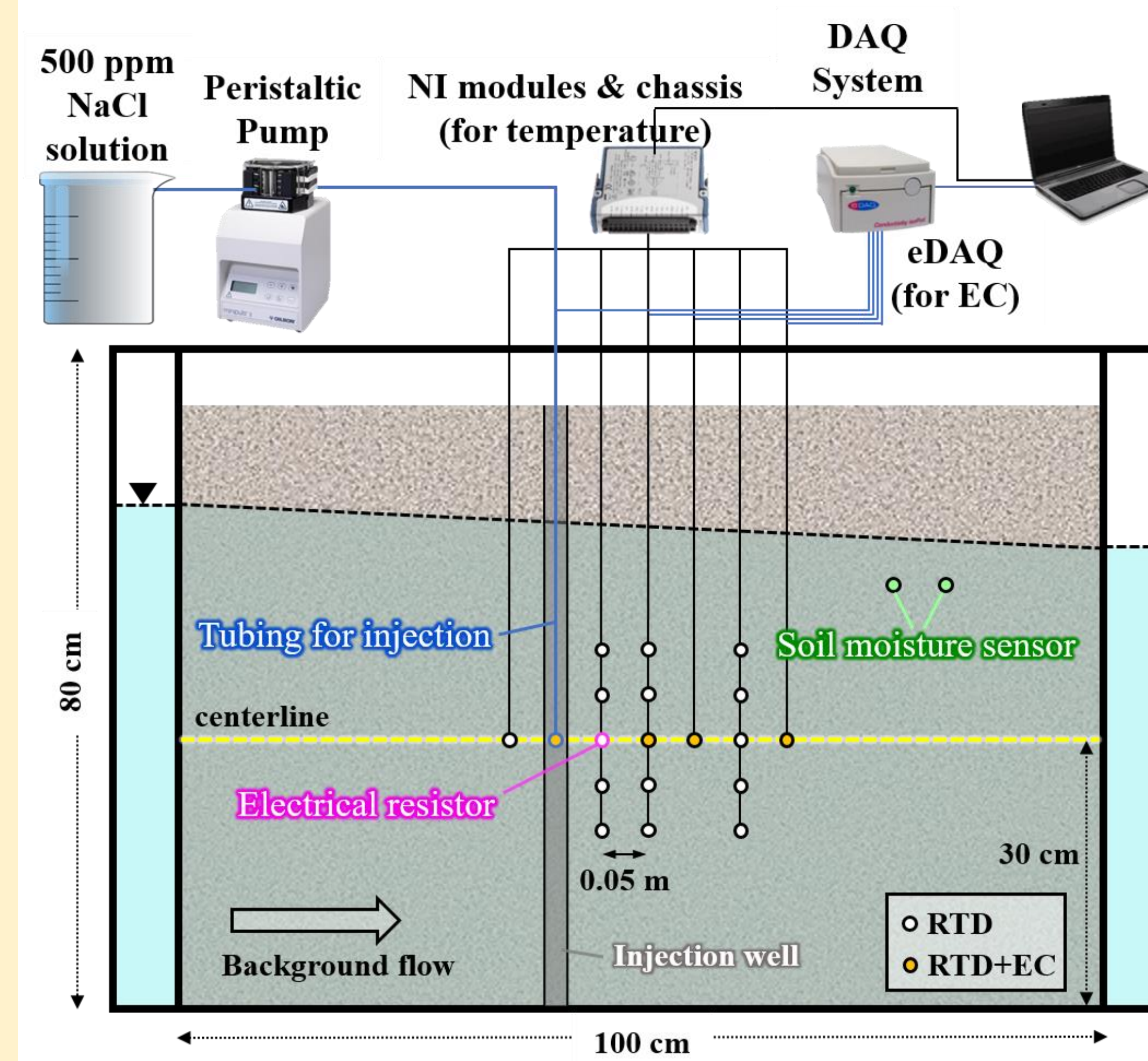
❖ An example of curve fitting results for heat tracer test
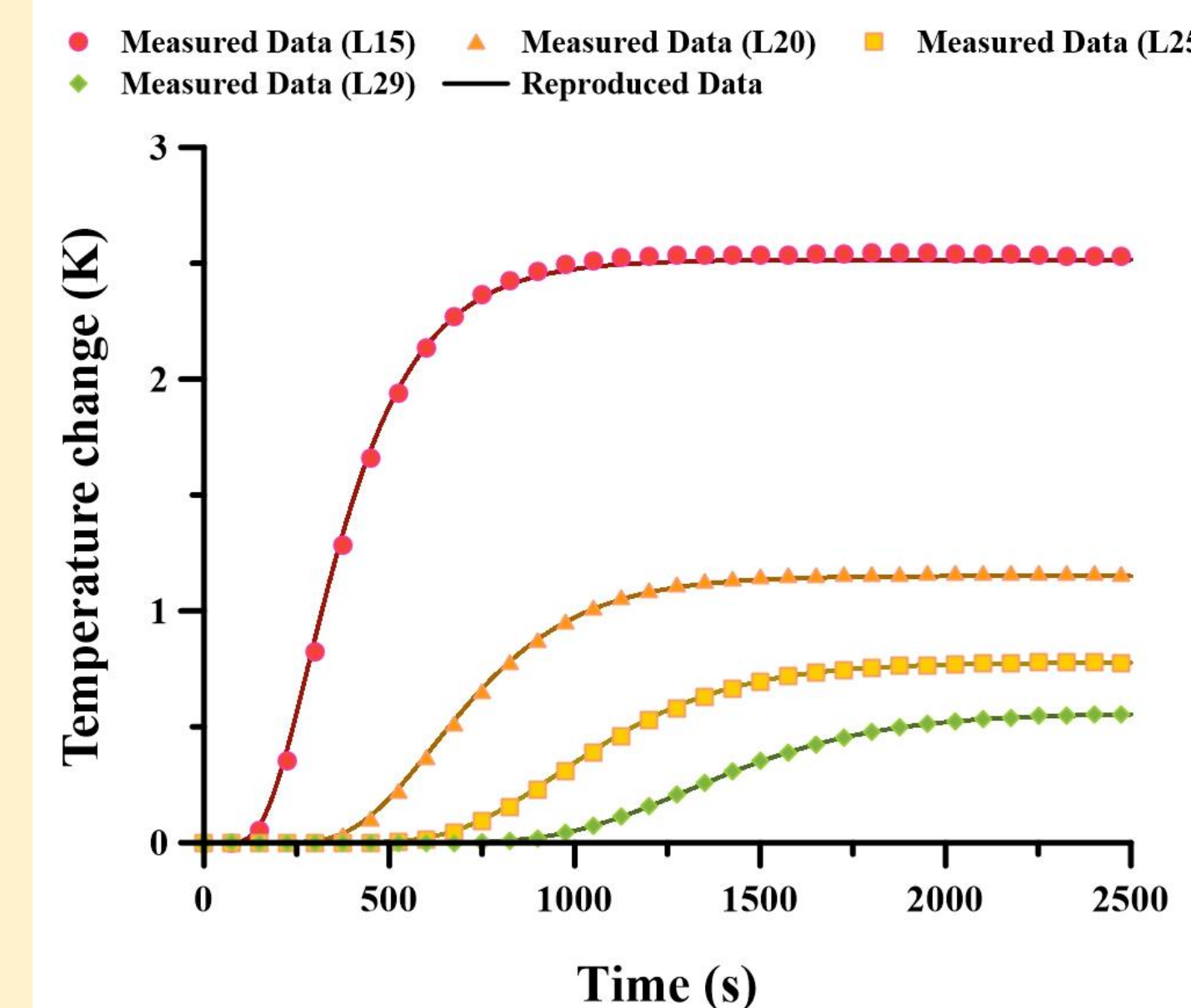

Curve fitting using analytical solution

> TAKE-HOME MESSAGE <

Particle size can affect

the relationship between velocity

and dispersion coefficients

only for heat transport,

not for solute transport.
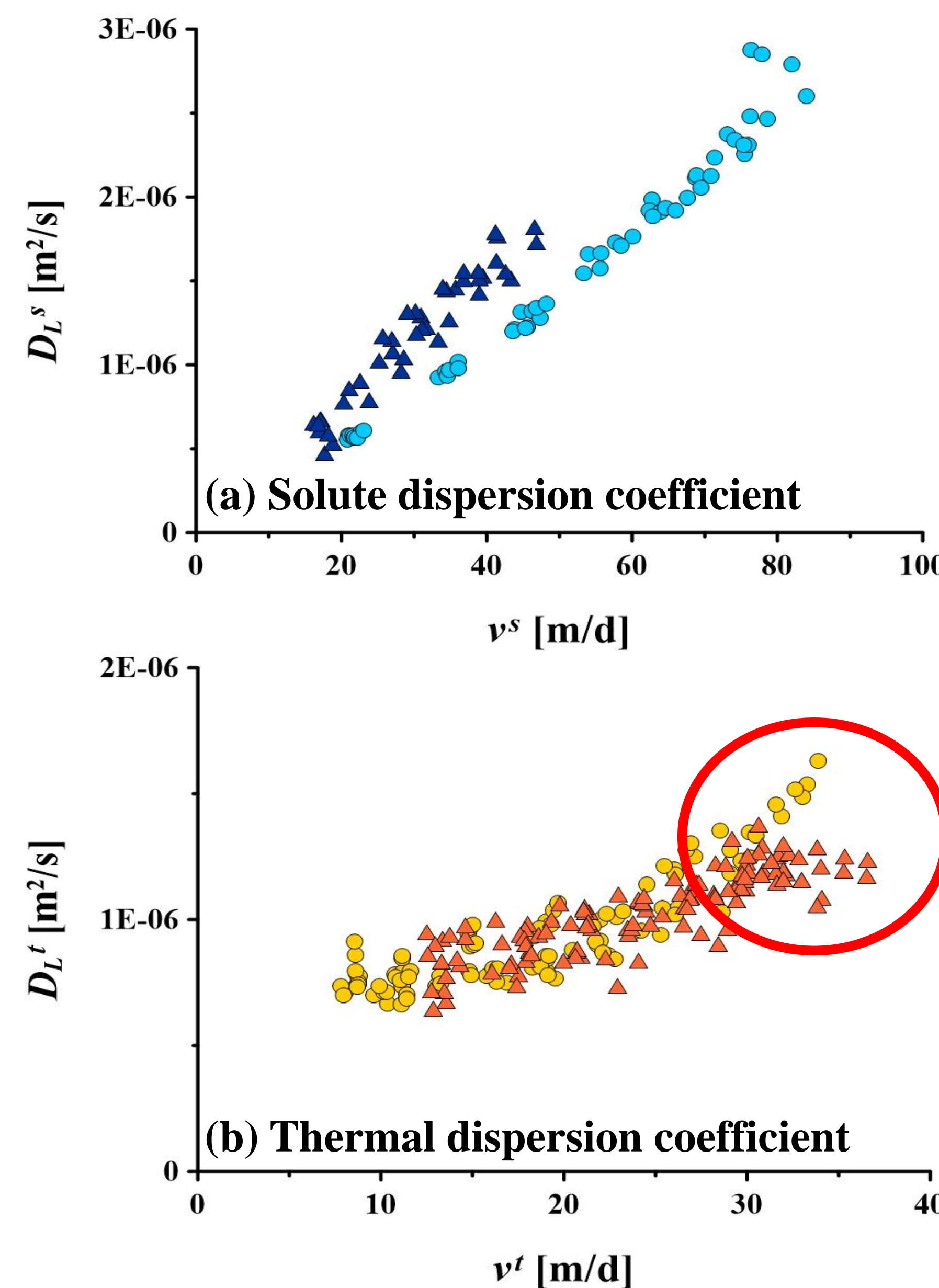
● SOLUTE AND HEAT TRANSPORT

- **Solute and thermal front velocities (v^s, v^t)**

❖ Tracer front velocities for two different sands

(a) Solute front velocity

(b) Thermal front velocity
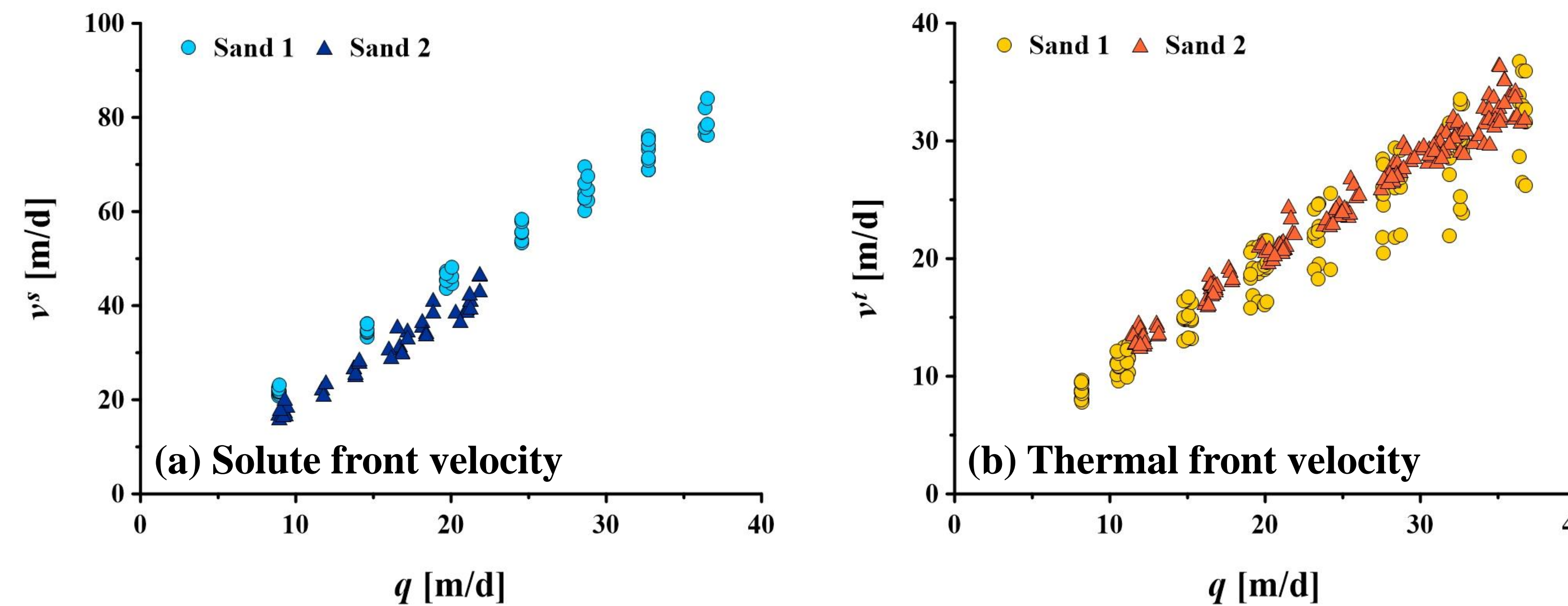
- **Longitudinal solute and thermal dispersion coefficients (D_L^s, D_L^t)**

❖ Tracer dispersion coefficients for two different sands

(a) Solute dispersion coefficient

(b) Thermal dispersion coefficient

Abstract QR code

● DIMENSIONLESS NUMBERS

- **Peclet numbers (Pe)**

$$Pe^{s,t} = \frac{v^{s,t} d_{50}}{D_0^{s,t}}$$

Parameters
v: tracer front velocity [L/T]
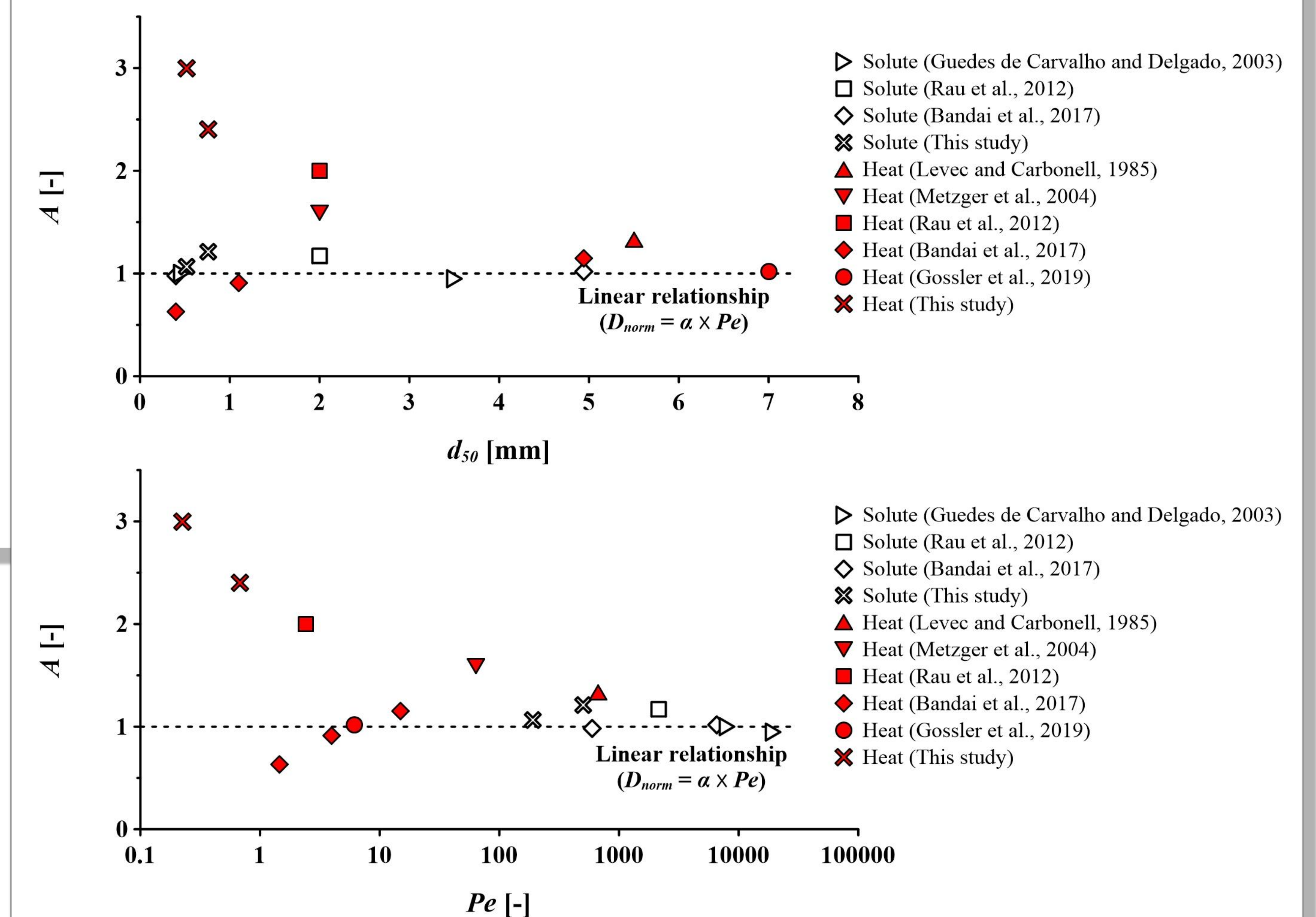D_0: diffusion coefficient [L²/T],
Subscripts
s: solute, t: thermal

● PARTICLE SIZE IMPACTS ON THE RELATIONSHIP BETWEEN VELOCITY AND DISPERSION COEFFICIENTS

$$D_{norm}^s = B * (Pe^s)^A$$
$$D_{norm}^t = 1 + B * (Pe^t)^A$$

➢ "A" determines the power law relationship between velocity and dispersion coefficients!

Solute (Guedes de Carvalho and Delgado, 2003)
Solute (Rau et al., 2012)
Solute (Bandai et al., 2017)
Solute (This study)
Heat (Levec and Carbonell, 1985)
Heat (Metzger et al., 2004)
Heat (Rau et al., 2012)
Heat (Bandai et al., 2017)
Heat (Gossler et al., 2019)
Heat (This study)