Developing confidence in critical state soil mechanics

11. Determining ψ insitu – the CPT

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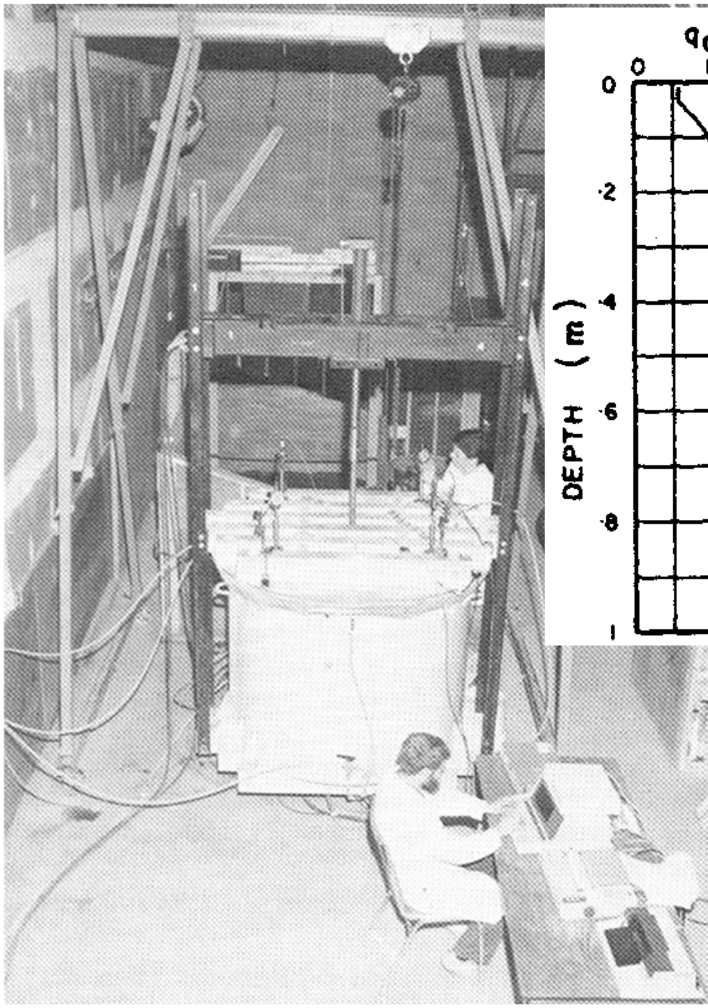
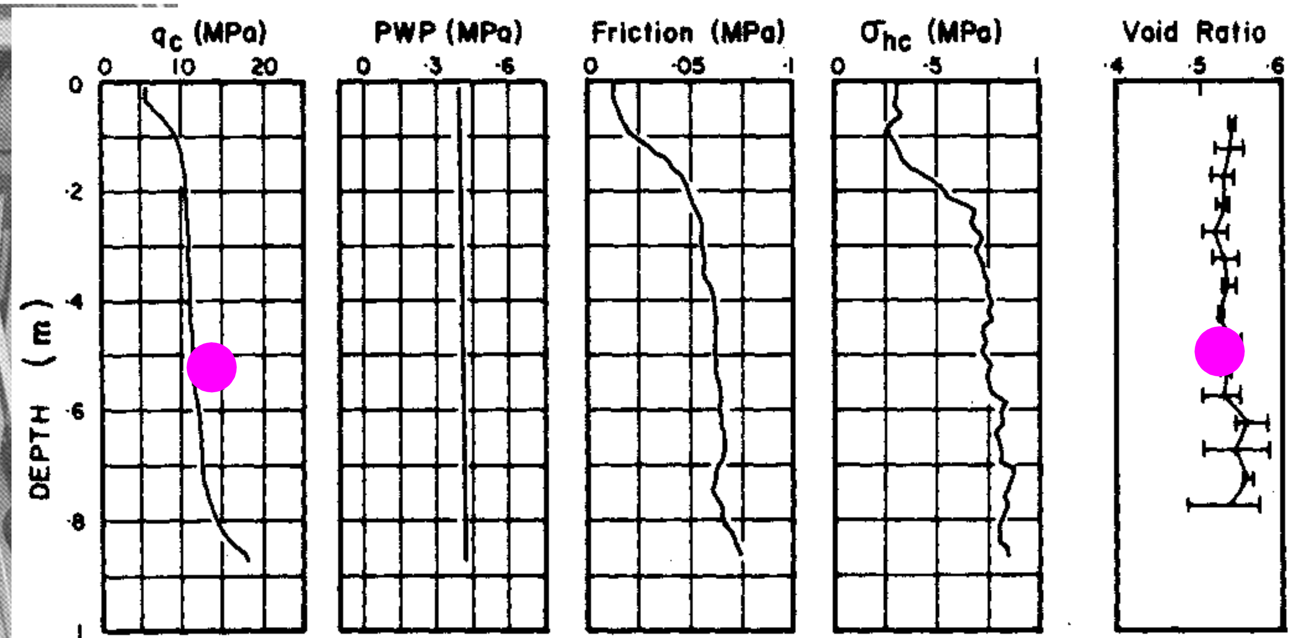
Calibration chamber for the CPT

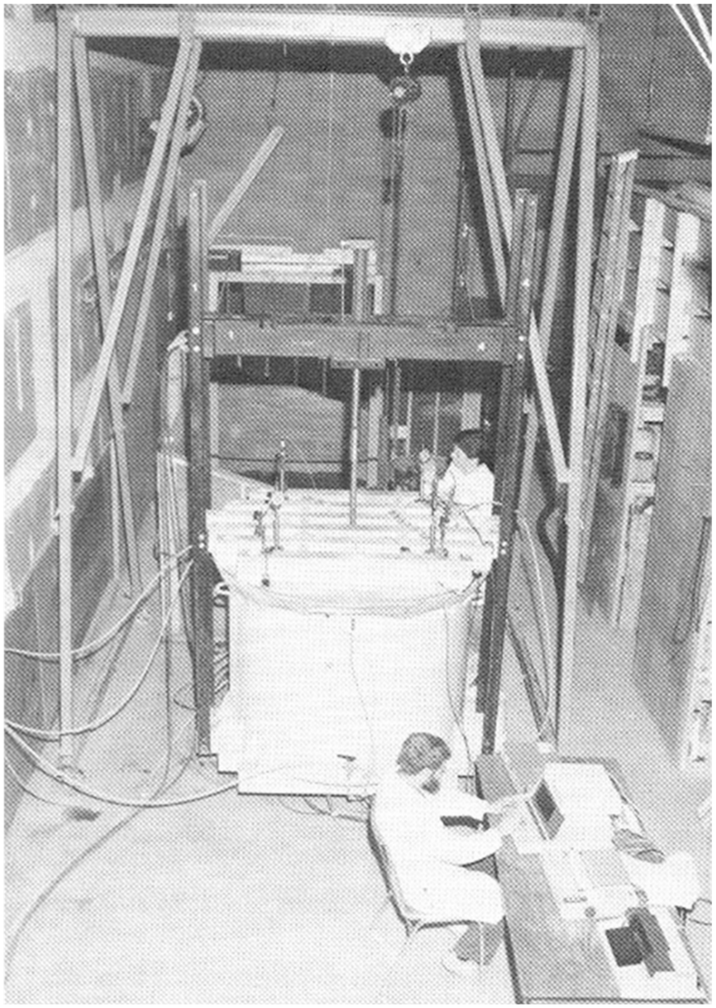


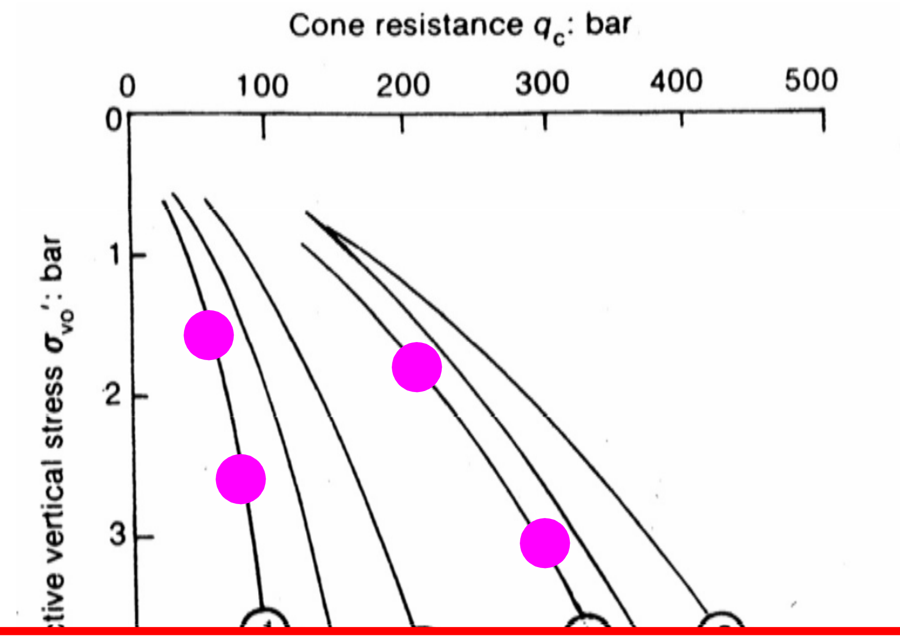


…see Book for complete set of world's calibration chamber data

Esso Resources Canada, Dome Petroleum, Gulf Canada Resources

Sorting out CPT “interpretation”



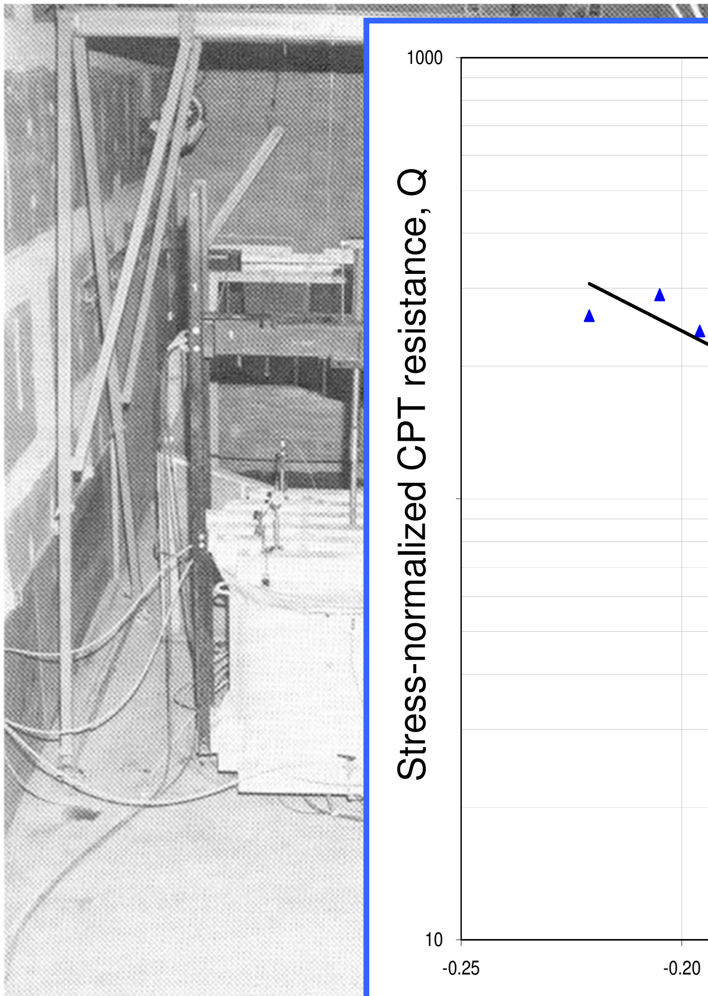


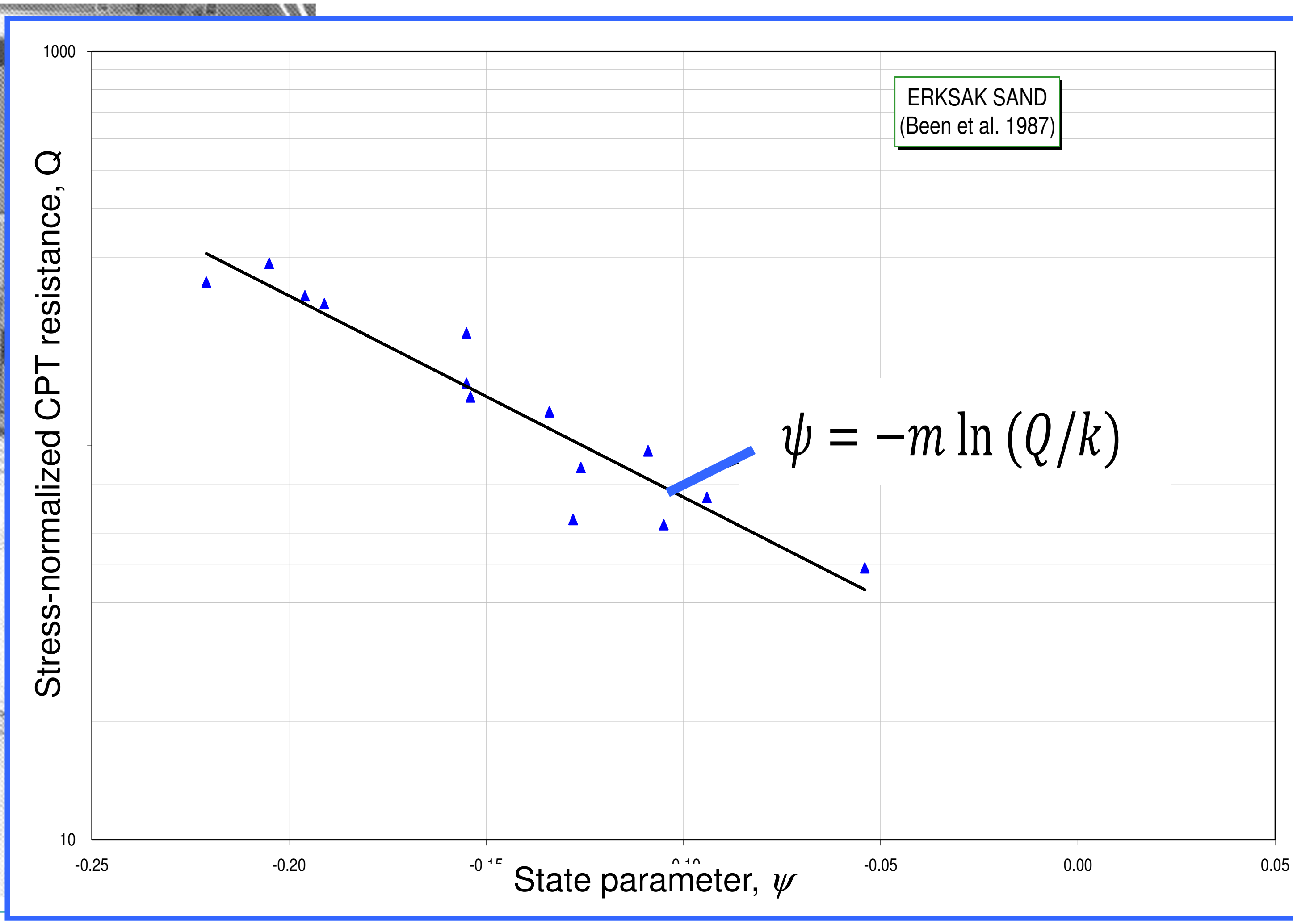
BASIC ISSUES

1) How stress level affects q_c-D_r
2) How soil properties affect q_c-D_r
3) And what about silts ?

Getting ψ from the CPT

Been et al (1987)





Esso Resources Canada, Dome Petroleum, Gulf Canada Resources

Sladen's intervention…

Sladen, J. A. (1989). *Géotechnique* **39**, No. 2, 323–332

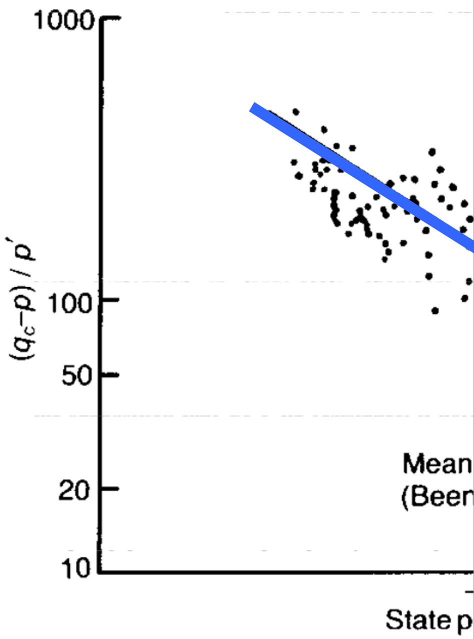
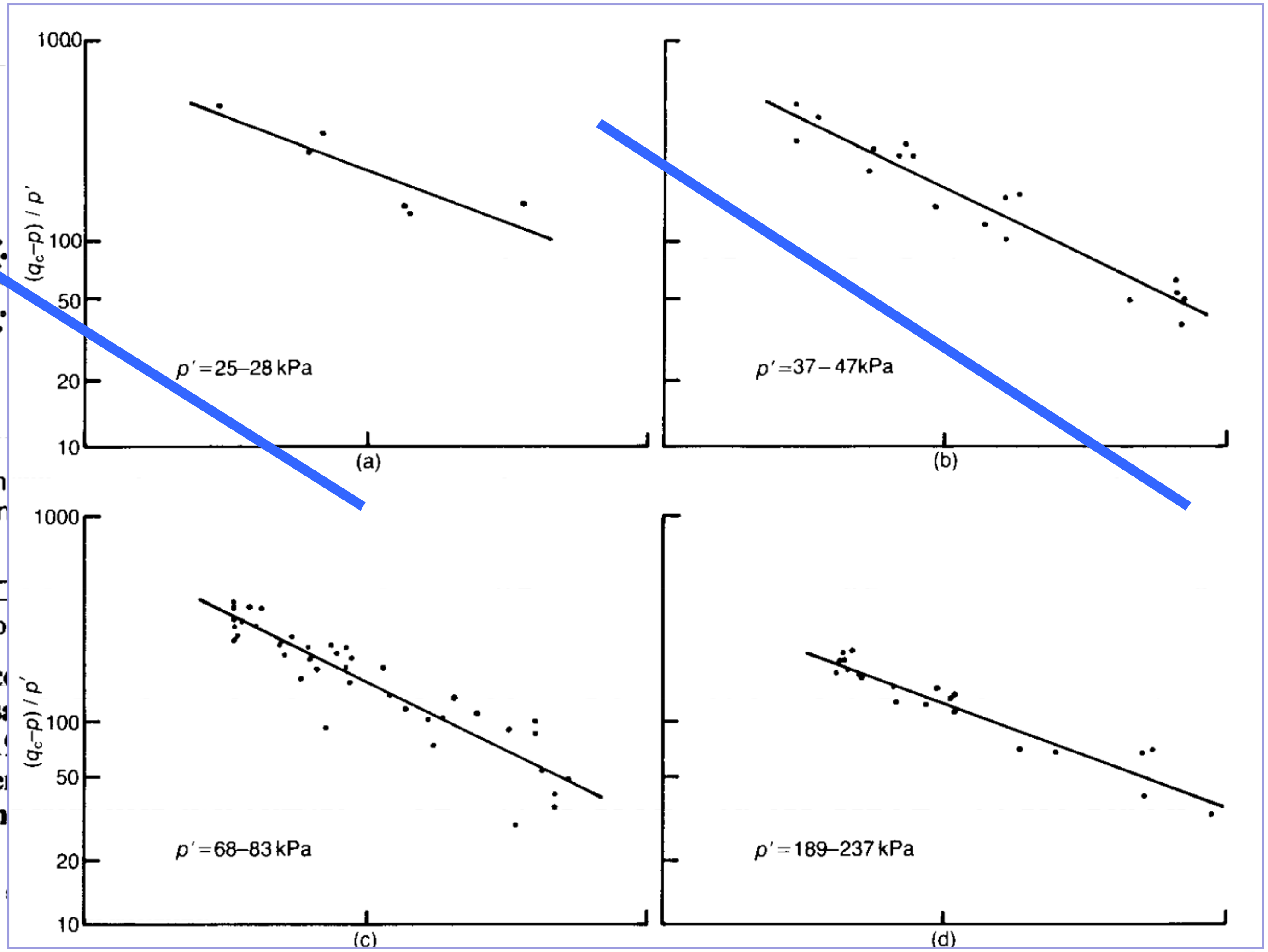


Fig. 3. Normalized tip resistanc
normally consolidated Ticino s
data presented by Baldi *et al.* (1
for Ticino sand presented by Bee
the mean relationship for this san



KEYWORDS: cone penetration test; sands;
parameter; liquefaction.

At some point you have to do “the math”

- Need large displacement computations
  - ‘moving mesh’ convects work and this needs including in solution
  - convection also depends on dilation
  - Appears simple, but actually rather sophisticated numerics

- Approach
  - Verify numerical implementation against constant friction, constant dilation soil for which “semi” closed-form solutions exist
  - Verify numerical implementation of NorSand against direct integration for laboratory element tests
  - Combine two verified modules to compute CPT behaviour

Time to "fess up"…

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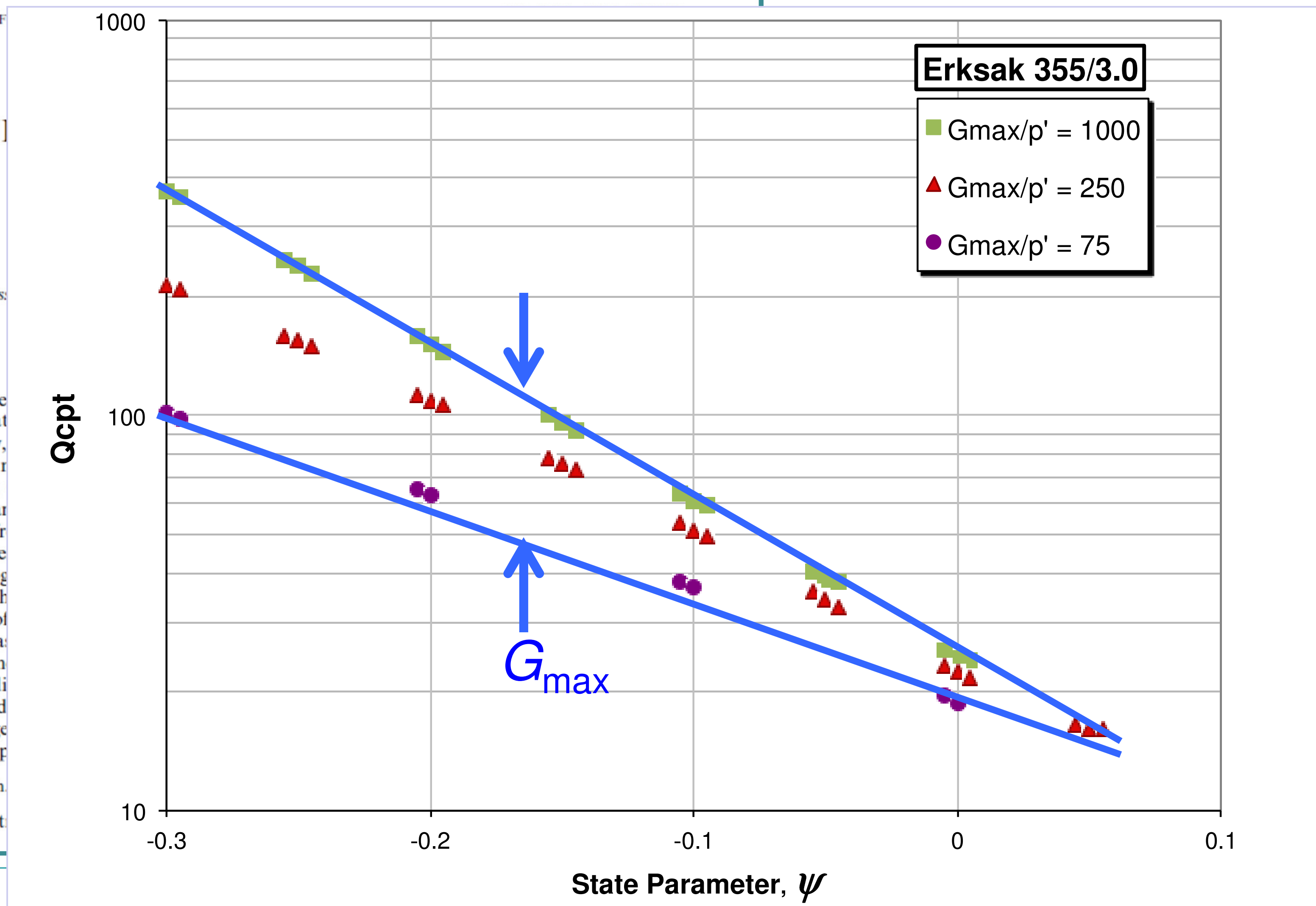
DIMENSIONI

[2] Golder As

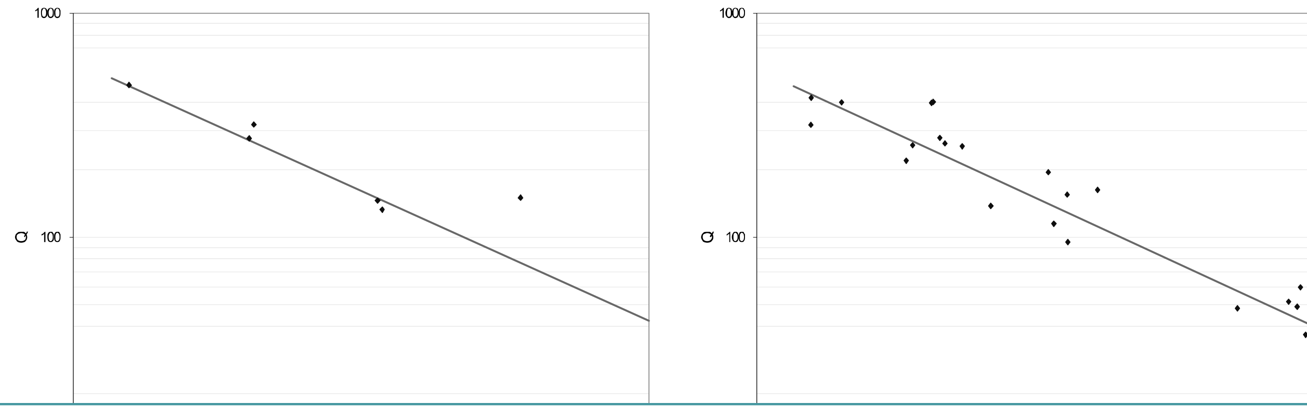
The cone penetration te
tool its excellent repeat
A continuing difficulty,
parameters of interest r
difficult. To date most
carried out in large char
in the CPT response fr
speculative) because the
cavity expansion analog
develop a pattern of beh
that one of the issues of
caused by neglect of ela
cavity expansion in san
chamber sands in predi
extreme care is required
approaching that sugge
particular care in interp

Int. J. Numer. Anal. Meth.

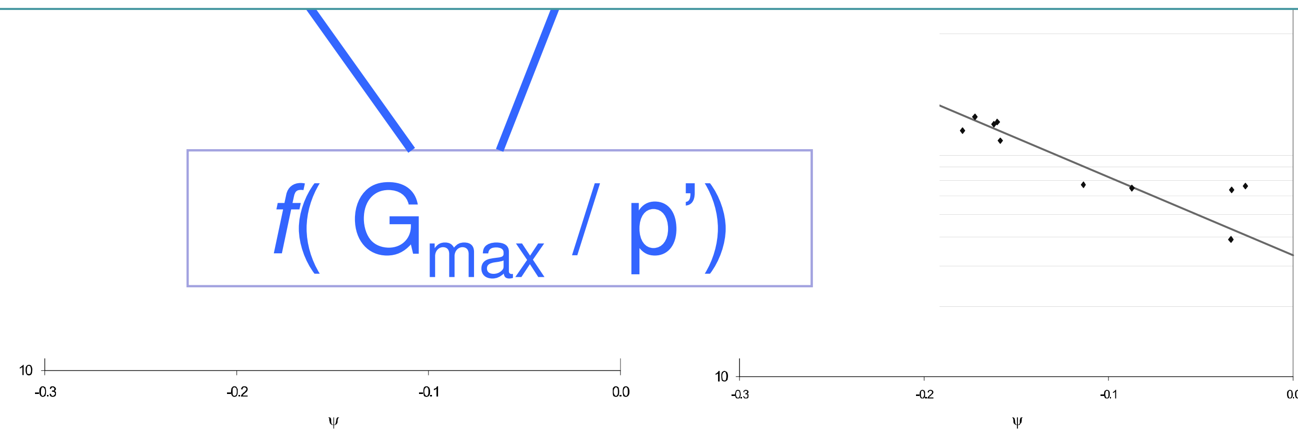
Key words: cone penet



Effect of G_{max} on Ticino CPT calibration



"Variable exponent" normalizations of CPT data are attempting to approximate the effect of G_{max} on the penetration resistance *(and doing so badly)*



(c) 65 < p' < 85 kPa

(d) 185 < p' < 240 kPa

Site-specific CPT calibration

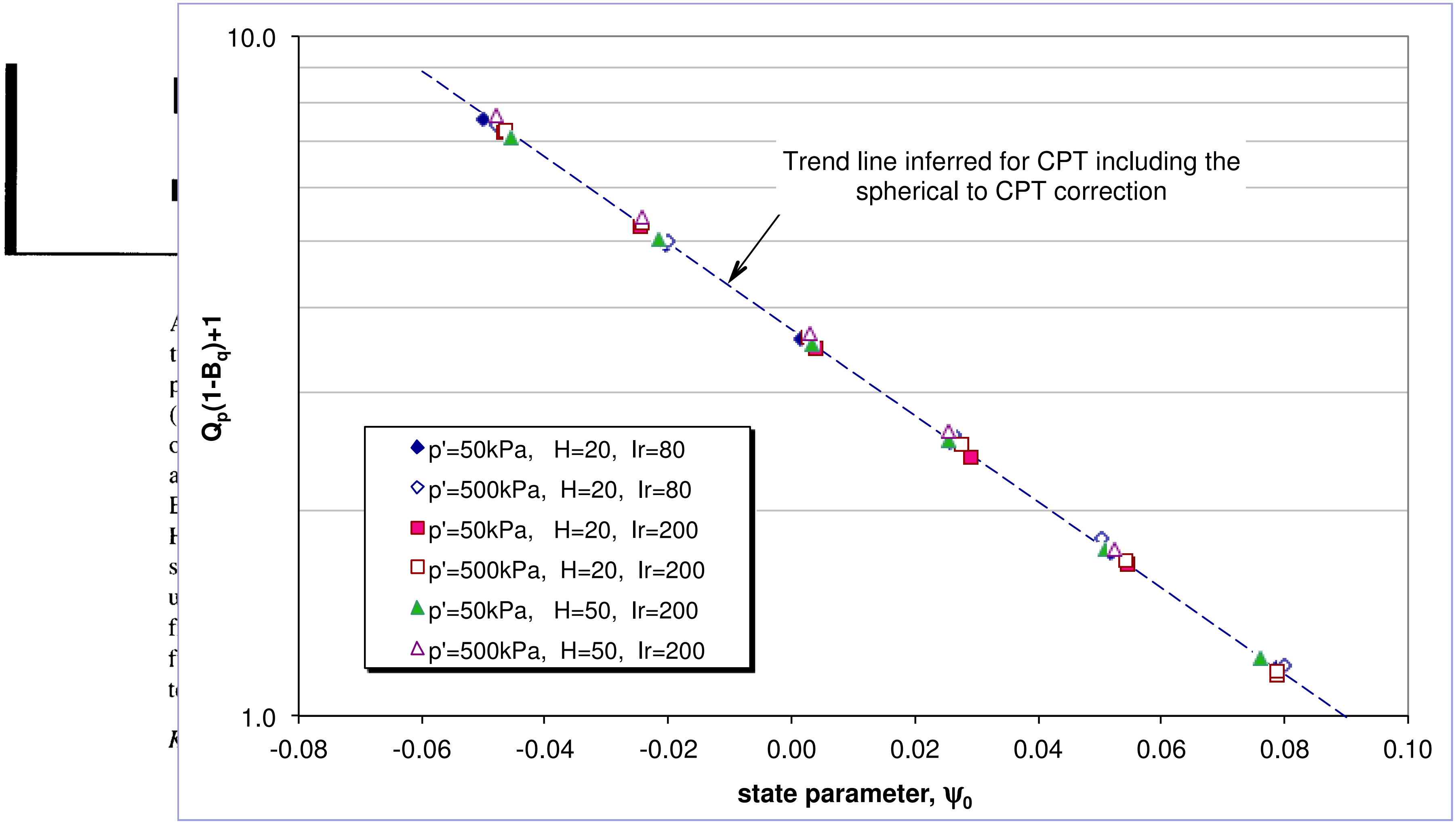
- Cavity expansion of NorSand is a pretty good analogue to CPT penetration resistance in calibration chambers

- Determine soil properties
  - M, N, λ_{10}, χ, H… reconstituted samples
  - Measure G_{max} insitu
  - And then there is K_0… 0.7 in alluvial deposits ?

- Use numerical method
  - Trend-fits for parametric simulations… in hand out
  - Use “widget”

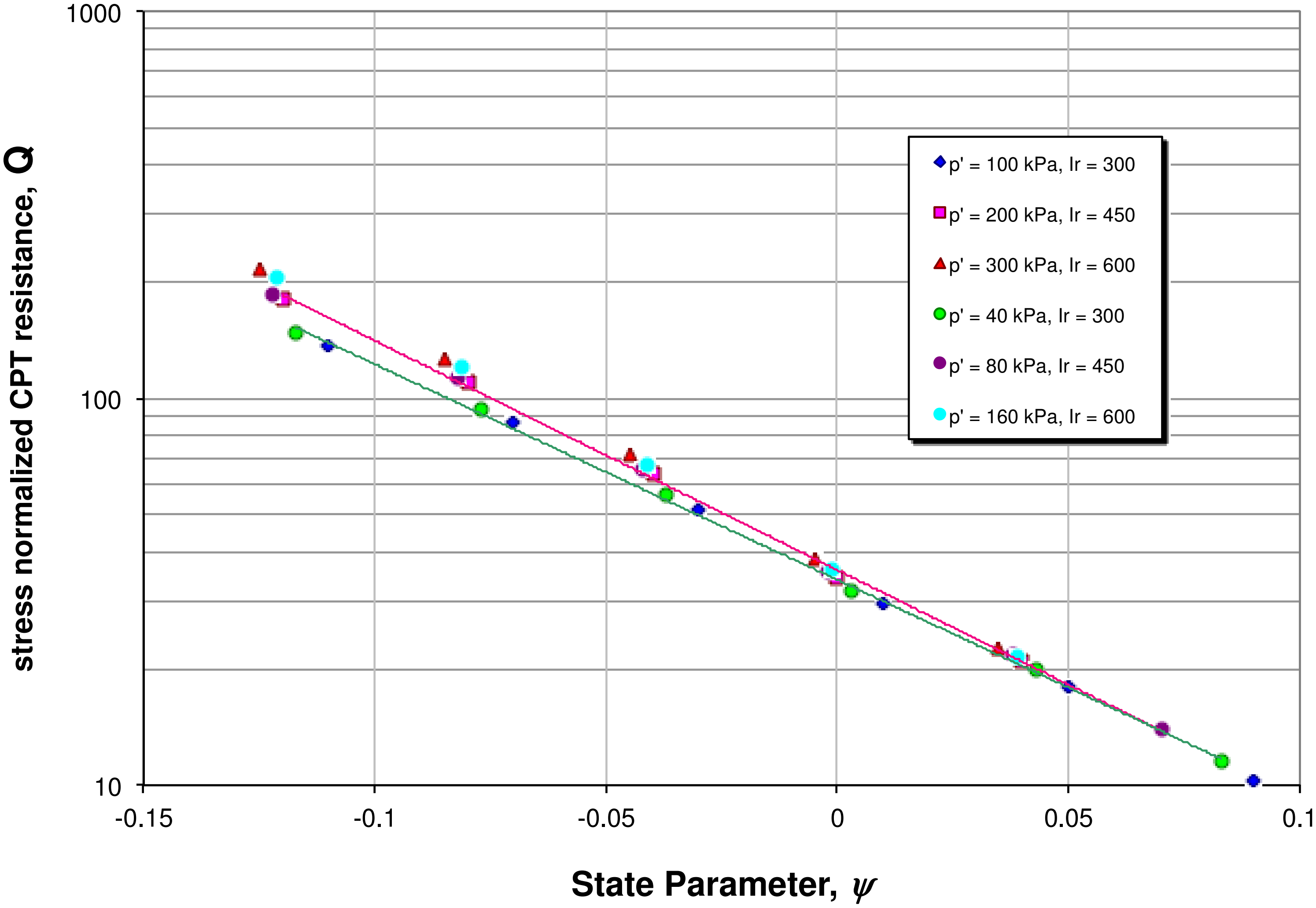
What about variable geology ?

Moving from sands to silts: $Q(1-B_q) + 1$



Houlsby (1988)

Understanding CPT via numerics…



$$Q_p = \frac{q_t - p}{\bar{p}} = k \exp(-m\psi)$$